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ABSTRACT

This volume replaces and updates a prior publication (January 1973) of unpublished evaluation instruments in science education. The six chapters of the publication describe instruments classified into: (1) those assessing student achievement in knowledge and understanding of science facts, principles, and concepts (grouped according to science content area); (2) those assessing student achievement in science processes and skills; (3) those measuring student characteristics and abilities either related to performance in science or developed by effective science instruction, e.g. curiosity, critical thinking; (4) those assessing student interests and attitudes in science, science classes, and science-related areas of knowledge; (5) those measuring student knowledge of aspects of the scientific enterprise, including its interrelationships with society; and (6) those measuring various school practices. The instruments identified are listed at the beginning of each chapter and, in general, are grouped according to factors measured. The educational level of the target group is indicated, with the instruments being arranged in alphabetical order by author's last name. (PEB)

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SCIENCE EDUCATION INFORMATION
REPORTS

UNPUBLISHED EVALUATION INSTRUMENTS IN SCIENCE EDUCATION: A HANDBOOK

by

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April, 1974

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Stanley L. Helgeson
Editor

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INTRODUCTION

The Handbook has been developed to provide the researcher in science education with a ready and comprehensive source of information on evaluation instruments, not available through a commercial publisher, that have been designed for science education studies. In the past much energy has been devoted to developing instruments for characteristics measurable by already existing instruments. It is hoped that the Handbook will find wide acceptance and result in more frequent utilization of available instruments reducing duplication of effort.

Instruments were identified in two ways. A questionnaire was sent to members of the National Association for Research in Science Teaching in the Autumn of 1970 requesting information on instruments developed at the member's institution. A follow-up questionnaire was mailed a year later. Twenty-four instruments were identified in this manner. The bulk of the 293 instruments, however, were identified through a search of the holdings of the Science, Mathematics, and Environmental Education Information Analysis Center of the ERIC System. Most were developed between 1964 and 1974. The compilation is comprehensive for that time period.

The following criteria were used in determining whether an instrument was to be included in the Handbook: 1) Objectivity - The instrument and its scoring system is readily usable by researchers. Most instruments are of the "objective" type. 2) Respondent-completed - The instrument measures some characteristic of the respondent or records his perceptions of events or materials. Researcher-completed observational instruments are not included. 3) Availability - The instrument is available from one of several sources; ERIC microfiche collections for instruments in documents referenced in this publication with an ED number, a journal article for those few instruments which have been published in this way, directly from the author or his institution, or in the Appendix of this Handbook. 4) General usefulness - Many instruments reviewed were designed to evaluate local curricula or to determine cognitive or affective outcomes of specific instructional media. Unless such instruments presented a novel format or design, they were not included.

Instruments available through commercial publishers are not included in this Handbook. They have been described in a publication entitled Standardized Science Achievement Tests, a compilation by Janet Wall and Lee Summerlin, published by the National Science Teachers Association, 1201 Sixteenth Street, N.W., Washington, D.C. 20036. It is available at a price of $1.50 plus postage and handling. It describes 31 instruments.

INSTRUMENT DESCRIPTION

The description of each instrument has been developed to provide sufficient information for the researcher to identify those having the general characteristics he desires. In most cases it will be necessary to go to the original study to obtain sufficient information to choose between similar instruments. The following format has been used in describing the instruments;

Title: In most cases the title assigned by the author is used. Those enclosed in brackets [ ] have been developed by the compiler either because one did not exist or because the original title was not descriptive of the instrument.

Factors: A brief description of the characteristics or variables the instrument measures.

Format: The number and types of items, and any subtest breakdown.

Population: The educational level and, where known, the geographic area and socio-economic level of the subjects.

Reliability: The value obtained, the method used, and the size of group used in determining reliability are provided. Where the phrase "Not Available" appears, this information could not be located in the study; usually because reliability estimates had not been made.

Norms: Very few of the instruments included in the Handbook have been standardized. Where readily available, however, means and standard deviations or standard errors are provided. Unless otherwise indicated, the maximum possible score is equal to the total items on the instrument as given under the heading, Format.

Validation: A brief statement or description of the validation techniques if any. Occasionally very extensive validation techniques were used. In order to conserve space, only those that seemed appropriate for general use of the instrument are cited. Where the phrase "Not available" appears information on validity could not be located.

Reference: Where the complete instrument can be found. Usually this is a reference to the original study. Where the original study is not readily available the reference may be to another study with the instrument. If the citation "Appendix" followed by a page reference appears, the complete instrument has been included in the Appendix of this Handbook.

ORGANIZATION OF THE HANDBOOK

The instruments were categorized into six groups providing the basis for the six chapters of the Handbook. The first five chapters include instruments which assess some student variable:

1) Student achievement in knowledge and understanding of science facts, principles and concepts. Instruments are grouped according to the particular area of science, e.g. biology.

2) Student achievement in the processes and skills used by the scientist; problem solving, process skills, laboratory skills and inquiry behaviors.

3) Student characteristics and abilities which are either related to performance in science or developed by effective science instruction. They include curiosity, critical thinking ability, verbal ability, cognitive preference and past experience.

4) Student attitudes and interests in science, science classes, and science related areas of knowledge.

5) Student knowledge of aspects of the scientific enterprise including its interrelationships with society.

The last chapter includes instruments designed to assess various school practices. One group concerns characteristics of instruction including the respondents knowledge of the practices, the degree to which they may be used in a classroom and student or teacher attitude toward certain practices. Others are concerned with supervisory practices, curriculum or facilities.

To assist the user of the Handbook, the instruments are listed at the beginning of each chapter or section. Generally they are grouped according to factors measured by the instrument. The educational level of the targeted respondent-group is also indicated. Within each sub-group the instruments are arranged in alphabetical order according to the last name of the author.

Frequently Used Symbols

Statistical

r	reliability
K-R 20	Kuder-Richardson 20 reliability technique
N	population size
X	mean
S.D.	standard deviation
S.E.	standard error

Curriculum Project

BSCS	Biological Sciences Curriculum Study
CBA	Chemical Bond Approach
CHEMS	Chemical Education Materials Study
ESCP	Earth Science Curriculum Project
IPS	Introductory Physical Science
ISCS	Intermediate Science Curriculum Study
PSNS	Physical Science for the Non-Science Student
SAPA	American Association for the Advancement of Science - Science, A Process Approach
SCIS	Science Curriculum Improvement Study
AAAS	American Association for the Advancement of Science

CHAPTER ONE

ACHIEVEMENT IN SCIENCE

The instruments in this chapter measure achievement in the knowledge and/or understanding of certain science facts and/or concepts. They have been grouped into three major areas of science; Biological Sciences, Earth and Environmental Sciences, and Physical Sciences. Each grouping is further subdivided as appropriate. A fourth major group includes all those instruments which cut across two or more of the broad disciplines identified above. The educational level of the targeted respondent-group is also indicated by a code letter.

Section 1: Biological Sciences

Instrument Title	Level*	Page
General Biology		
Life Science Concept Test	E	7
[Biology Topics Examination]	S	7
General Biology - Final Exam	C	8
[Biological Topics Tests]	C	8
Biology Test	S	9
BSCS Biology, SM Evaluation 1968-69 (Unit Tests)	S	9
The Biological Principles Test	S	11
[Test on Respiration]	J	11
The Biological Princepts Test	S	12
Examination in Biology	S	12
[Spurlin Biology Test]	C	13
[Cell Concepts Test]	E	13
[Biological Topics Test]	S	14
Botany		
Botany Factual Examination	C	15
Ecology		
[Ecological Concepts Test]	J	15

*Code: E - Elementary School Students, J - Junior High School Students, S - Senior High School Students, C - College Students, Inservice Teachers and other adults, VOC - Vocational or Technical School Students.

Instrument Title	Level*	Page
Genetics		
[Genetics Examination]	S	16
Examination for Programmed Genetics Unit	S	16
Health		
Health Opinionnaire	S	17
Organic Evolution		
Achievement Test of Organic Evolution Concepts	S	17
Achievement Test of Organic Evolution Principles	S	18
Zoology		
Zoology Final	S	18

Title: LIFE SCIENCE CONCEPT TEST

Factors: Selected life science concepts

Format: Six pictures are presented for each concept; each picture representing a characteristic of the concept. Understanding is assessed on basis of student responses to each picture.

Population: Children in grades one through six

Reliability: $r = .84 - .94$ (Test - retest) $N = 192$

Norms: $\bar{X} = 6.22$ S.E. = .64 (grade two)
$\bar{X} = 18.91$ S.E. = 1.25 (grade six)

Validation: Concurrent validity; correlation coefficient with Otis Test of Mental Ability ranged from 0.31 to 0.67.

Reference: Butler, Franklin D. "A Test for Measuring Selected Life Science Concepts of Elementary School Children." Unpublished doctoral dissertation, George Peabody College for Teachers, 1965, p. 74.
University Microfilms Order No. 66-4412

Title: [BIOLOGY TOPICS EXAMINATION]

Factors: Knowledge of biology topics; Heredity, Narcotics, Reproduction, Physiology.

Format: Multiple-choice and true-false items

Population: Secondary school biology students in Denver, Colorado

Reliability: Not available

Validation: Not available

Reference: Hofwolt, Clifford Anton. "An Exploratory Study on the Effect of Self-Evaluation: Inventories on Student Achievement in High School Science Courses." Unpublished doctoral dissertation, University of Northern Colorado, 1971, p. 81.
University Microfilms Order No. 72-3268

Title: GENERAL BIOLOGY - FINAL EXAM

Factors: Achievement in biology

Format: 80 multiple-choice items

Population: General Biology students in Jamestown Community College and in the State University of New York at Buffalo

Reliability: Not available

Validation: Content validity based on table of specifications for course content common in the two schools. Most items taken from Dressel and Nelson *Questions and Problems in Science* (1960).

Reference: Kochersberger, Robert. "A Comparison of Achievement of General Biology Students in a Community College with Similar Students in a University as Related to Their Backgrounds." Unpublished doctoral dissertation, State University of New York at Buffalo, 1965, pp. 110-119.
University Microfilms Order No. 65-8896

Title: [BIOLOGICAL TOPICS TESTS]

1) Homeostasis
2) Level of Organization
3) Plant Kingdom
4) Metabolic Rate Test
5) Problems in Botany

Factors: Knowledge acquisition (1-3), analytic ability (4-5)

Format: 15 to 20 true-false or multiple-choice items on each instrument

Population: Freshman and sophomore elementary education majors

Reliability: Instruments 1-3; $r = .76 - .82$ (Pearson product-moment correlation of split-half analysis)
Instruments 4-5; $r = .67 - .74$ (Pearson r correlation of test-retest scores)

Validation: Not available

Reference: Kuhn, David J. "A Study of Varying Modes of Topical Presentation in Elementary College Biology to Determine the Effect of Advance Organizers in Knowledge Acquisition and Retention." Unpublished doctoral dissertation, Purdue University, 1967, pp. 169-187. University Microfilms Order No. 68-6326

Title: BIOLOGY TEST

Factors: Achievement in biology

Format: 74 multiple-choice items

Population: Students enrolled in 10th grade biology classes

Reliability: Not available

Norms: $\overline{X} = 52.66$ (Control pretest)
$N = 86$

Validation: Method by Guertin (unpublished) used to establish lack of bias in instrument between experimental and control groups.

Reference: Marshall, Gail. "The Development and Evaluation of a Programed Supplementary Guide for Selected Topics in High School Biology." Unpublished doctoral dissertation, The University of Florida, 1970, p. 262. University Microfilms Order No. 71-12,763

Title: BSCS BIOLOGY, SM EVALUATION 1968-69 (Unit Tests)

Factors: Achievement in five areas of the course materials of Biological Science: Patterns and Processes. The areas include; ecological relationships, cell energy processes, reproduction and development, genetic continuity, and organic evolution.

Format: Two test forms (A and B) were developed for each of the five areas. Tests consist of multiple-choice items.

Population: Students using the Biological Science: Patterns and Processes; primarily suburban and rural 10th graders, with some inner-city students and 9th, 11th and 12th grade students.

Instrument Statistics:

Test	N		r*		SE*		$\bar{X}$**		Number of items
	A	B	A	B	A	B	A	B	
Ecology	289	320	.70	.72	8.2	7.9	75	70	24
Cell Energy Processes	259	245	.73	.74	9.42	9.41	51	54	30
Reproduction and Development	220	226	.71	.74	9.3	8.9	53	53	30
Genetic Continuity	189	213	.68	.66	9.3	8.7	53	37	27-26
Evolution	No information								16

Pretest statistics on each of the two forms (A and B) for four unit tests.

* Hoyt analysis of variance

** % correct

Validation: Each area of study was analyzed for concepts which then served as guides for item development.

Reference: Mayer, William V., et al. "A Formative Evaluation of Biological Science: Patterns and Processes." Final report Project No. 9-H-012, U.S. Department of Health, Education and Welfare, March, 1970.
ED 039 149 MF $0.65 HC $9.87 262 pp.

Title: THE BIOLOGICAL PRINCIPLES TEST

Factors: Ability to identify and apply major biological principles

Format: 50 multiple-choice items

Population: High school seniors

Reliability: r = .73 (Split-half technique with Spearman-Brown correlation)
N = not available

Norms: $\overline{X} = 25.28$ Variance = 35.48 N = 1275

Validation: Content validity estimated from comparison with published lists of biological principles. Construct validity established through evaluation of items by high school biology teachers.

Reference: Pierson, David W. "The Ability of High School Seniors to Identify and Apply Biological Principles in Problem-Solving Situations." Unpublished doctoral dissertation, University of Missouri, 1962, p. 106.
University Microfilms Order No. 65-4169

Title: [TEST ON RESPIRATION]

Factors: Knowledge of respiration (BSCS unit)

Format: 40 multiple-choice items

Population: 9th grade biology students

Reliability: r = .86 (K-R 20) N = 180

Validation: Items were selected from questions contributed by 12-member jury on basis of discrimination and difficulty indices using limits established by Garrett. (Henry Garrett, Statistics for Education and Psychology, New York: Longman, Green and Company, 1962, p. 351.)

Reference: Schuck, Robert F. "An Investigation to Determine the Effects of Set Induction Upon the Achievement of Ninth Grade Pupils and Their Perception of Teacher Effectiveness in a Unit on Respiration in the BSCS Curricula." Unpublished doctoral dissertation, Arizona State University, 1968, pp. 137-143.
University Microfilms Order No. 67-15,582

Title: THE BIOLOGICAL PRINCEPTS TEST

Factors: Ability to identify (Part II) and apply (Part I) selected princepts (principle concepts)of biology.

Format: 36 multiple-choice items

Population: High school biology students

Validation: Jury of high school biology teachers

Reference: Shipe, Richard Allen. "The Ability of Teacher-identified Non-college Bound High School Biology Students to Identify and Apply Selected Princepts of Biology." Unpublished doctoral dissertation, The Pennsylvania State University, 1972, Appendix.
University Microfilms Order No. 73-14,051

Title: EXAMINATION IN BIOLOGY

Factors: Knowledge of biological concepts

Format: Six subtests of 50 multiple-choice items each

Population: High school biology students

Reliability: Ranged from .71 - .81 on subtests. Established through alternate form method. (N = 421 to 607)

Norms: Percentile norms given on pp. 108-110 of dissertation

Validation: Concurrent validity for subtests established by comparison with total score. Content validity established by panel.

Reference: Simons, Harry A. "The Construction and Evaluation of High School Biology Unit Tests." Unpublished doctoral dissertation, New York University, 1967, p. 111.
University Microfilms Order No. 68-6185

Title: [SPURLIN BIOLOGY TEST]

Factors: Biological facts and concepts

Format: 50 multiple-choice items

Population: Students enrolled in first course in college biology

Reliability: r = .93 (Guilford method of rational equivalence)

Norms: $\overline{X}$ = 27.7 S.D. = 6.96 N = 234

Validation: Content validity determined by author

Reference: Spurlin, Melvin D. "A Study of the Relationships of Sex, Ability Level and Biological Preparation to Achievement in Freshman Biology at Metropolitan State College." Unpublished doctoral dissertation, University of Colorado, 1968, pp. 146-153.
University Microfilms Order No. 68-14,237

Title: [CELL CONCEPTS TESTS]

Factors: The achievement in concepts of the biological cell measured at three levels; Knowledge, Comprehension and Application (based on Bloom's Taxonomy).

Format: Combinations of multiple-choice and yes-no questions; 36 items on each of eleven tests

Population: Students in grades 2 through 6; 20 students from one class at each grade level

Reliability: Varied on each test between cognitive levels; maximum range - .47 to .73, minimum .83 to .89; range for total reliability .44 to .85.

Validation: Not available

Reference: Stauss, Nyles G. "Materials Used in Teaching and Evaluating the Concepts Related to the Biological Cell in Grades 2-6." Practical Paper #2, Wisconsin Research and Development Center for Cognitive Learning, The University of Wisconsin, 1968, pp. 22-26.

Title: [BIOLOGICAL TOPICS TEST]

Factors: Achievement on each of eight topics:

I Botany
II Nutrition and digestion
III Respiration
IV Blood and Circulation
V The Conquest of Disease
VI Learning and the Nervous System
VII Reproduction
VIII Genetics

Format: Objective items including matching, multiple-choice and true-false

Population: Ninth and tenth grade students of University High School, Minneapolis

Reliability: Hoyt's variation of K-R 20*

I r = .86
II r = .92
III r = .90
IV r = .83
V r = .76
VI r = .80
VII r = .84
VIII r = .83

*C. J. Hoyt "Note on a Simplified Method of Computing Test Reliability." Educational and Psychological Measurement, Vol. I:93-95, January, 1941.

Norms:

I $\overline{X}$ = 32.83 - 37.08 S.D. = 6.53 - 9.34 (53 items)
II $\overline{X}$ = 40.39 - 51.92 S.D. = 9.73 - 12.69 (66 items)
III $\overline{X}$ = 28.30 - 34.79 S.D. = 8.64 - 11.14 (66 items)
IV $\overline{X}$ = 37.70 - 44.33 S.D. = 6.26 - 7.71 (54 items)
V $\overline{X}$ = 20.09 - 25.04 S.D. = 4.72 - 5.97 (35 items)
VI $\overline{X}$ = 19.26 - 24.42 S.D. = 4.70 - 6.43 (32 items)
VII $\overline{X}$ = 24.35 - 30.85 S.D. = 5.97 - 7.93 (41 items)
VIII X = 19.61 - 22.77 S.D. = 4.73 - 6.45 (32 items)

Validation: Internal consistency determined through a method outlined by Frederick B. David, Items Analysis Data, Cambridge, Massachusetts: Harvard University, 1949.

Reference: Walters, Louis Lloyd. "A Comparison of Achievement in High School Biology When Taught to Ninth Grade and Tenth Grade Pupils." Unpublished doctoral dissertation, University of Minnesota, 1961, pp. 136-182.
University Microfilms Order No. 61-3690

Title: BOTANY FACTUAL EXAMINATION

Factors: Ability to record and identify specific items of information in botany

Format: 51 items including multiple-choice, short answer and pictorial

Population: Students enrolled in botany at the University of Toledo

Reliability: r = .81 (K-R 21) N = 84

Validation: Comparison of items with lecture topics for content validity

Reference: Gallentine, Jerry L. "The Effects of Overhead Projection on Achievement in the Biological Sciences at the College Level." Unpublished doctoral dissertation, The University of Toledo, 1965, pp. 76-78.
University Microfilms Order No. 66-0307

Title: [ECOLOGICAL CONCEPTS TEST]

Factors: Knowledge, comprehension and application of ecological concepts

Format: 60 multiple-choice items

Population: Seventh and ninth grade students

Reliability: r = .82 (Analysis of variance)

Norms: $\overline{X}$ = 22.34 S.D. = 8.29

Validation: Not available

Reference: Triezenberg, Henry J. "The Relative Effectiveness of Three Levels of Abstraction Representing the Conceptual Scheme of Equilibrium as an Advance Organizer in Teaching." Unpublished doctoral dissertation, University of Wisconsin, 1967, p. 316.
University Microfilms Order No. 67-17,040

Title: [GENETICS EXAMINATION]

Factors: Achievement in genetics

Format: Two forms consisting of 32 and 36 multiple-choice items respectively

Population: High school biology students in Caddo Parish School System, Louisiana

Reliability: r = .81 and .89 (Split-half)

Validation: Pool of 150 items selected from a variety of sources. Panel of experts constructed two 40-item tests and evaluated them for face validity, content validity and construct validity.

Reference: Johnson, Lester. "A Study of the Effects of Using Three Different Sets of Instructional Materials to Present a High School Biology Unit of Genetics." Unpublished doctoral dissertation, Northwestern State University of Louisiana, 1972, p. 95.
University Microfilms Order No. 72-28,519

Title: EXAMINATION FOR PROGRAMMED GENETICS UNIT

Factors: Achievement in genetics at knowledge, comprehension application and analysis levels

Format: 28 multiple-choice items

Population: Students enrolled in biology at a parochial high school in Chicago, Illinois

Reliability: N = 144 r = .67 (KR)
r = .74 (Spearman-Brown)

Norms: $\overline{X}$ = 17.4 S.D. = 3.63

Validation: Jury

Reference: Stedman, Carlton Herman. "The Effects of Prior Knowledge of Behavioral Objectives on Cognitive Learning Outcomes Using Programmed Materials in Genetics." Unpublished doctoral dissertation, Indiana University, 1970, p. 68.
University Microfilms Order No. 71-11,351

Title: HEALTH OPINIONNAIRE

Factors: Knowledge of health practices in nine areas: personal health, nutrition, rest and exercise, care and prevention of disease, habit-forming substances, first-aid, consumer health, family living and mental health.

Format: 100 statements with agree-disagree response format

Population: Seniors from Colorado high schools

Reliability: Not determined

Norms: $\bar{X} = 32.19$ $N = 240$

Validation: Jury of physicians, health educators and school nurses

Reference: Stephens, Gale Elouise. "Prevalence of Harmful Health Misconceptions in Colorado High School Seniors." Unpublished doctoral dissertation, University of Colorado, 1970, p. 105.
University Microfilms Order No. 71-5935

Title: ACHIEVEMENT TEST OF ORGANIC EVOLUTION CONCEPTS

Factors: Achievement about concepts of organic evolution

Format: 49 multiple-choice items

Population: Tenth grade students in Tempe, Arizona

Reliability: $r = .89$ (Split-halves)

Norms: (BSCS Students)
$N = 75$ $\bar{X} = 12.04$ S.D. = 5.36

Validation: Survey of high school biology teachers

Reference: Barrow, Wesley Charles. "A Comparison of Concept and Principle Learning About Organic Evolution Between Tenth Grade Students in a Biological Sciences Curriculum Study Course Versus a Course in Traditional Biology." Unpublished doctoral dissertation, Arizona State University, 1971, p. 106.
University Microfilms Order No. 71-13,209

Title: ACHIEVEMENT TEST OF ORGANIC EVOLUTION PRINCIPLES

Factors: Achievement about principles of organic evolution

Format: 42 multiple-choice items

Population: Tenth grade students in Tempe, Arizona

Reliability: r = .86 (Split-halves)

Norms: (BSCS Students)
N = 94 $\overline{X}$ = 9.35 S.D. = 5.45

Validation: Survey of high school biology teachers

Reference: Barrow, Wesley Charles. "A Comparison of Concept and Principle Learning About Organic Evolution Between Tenth Grade Students in a Biological Sciences Curriculum Study Course Versus a Course in Traditional Biology." Unpublished doctoral dissertation, Arizona State University, 1971, p. 106.
University Microfilms Order No. 71-13,209

Title: ZOOLOGY FINAL

Factors: Achievement in zoology content

Format: 75 matching and multiple-choice questions and three essay questions

Population: 10th grade biology students in Wausau, Wisconsin

Reliability: Not available

Norms: No overall mean or standard deviation given.
N = 176

Validation: Not available

Reference: Aaron, Gnanaolivu. "The Effectiveness of Programmed Instruction When Used to Supplement or Supplant Assignments in Biology Classes in Which Team Teaching Techniques are Employed." Unpublished doctoral dissertation, University of Wisconsin, 1965, pp. 109-114.
University Microfilms Order No. 65-5108

Section 2: Earth and Environmental Sciences

Instrument Title	Level	Page
Earth Science		
[Tests in Earth Science]	C	20
Earth Science Achievement Test	J	20
Student Earth Science Test	J	21
[Earth Science Concepts Tests]	J	21
[Earth Science Tests]	C	22
Air Pressure		
[Concepts on Air Pressure]	E	22
Anthropology		
Early Man in America	J	23
Astronomy		
[Charting the Earth Test]	E	23
Test in Collegiate Descriptive Astronomy	C	24
[Astronomy Unit Test] and Standard Astronomy Test	C	24
Charting the Universe Test	E	25
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Environmental Science		
What I know About Pollution	E	28
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Test of Oceanographic Knowledge	C	30
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Title: [TESTS IN EARTH SCIENCE]

Factors: Knowledge of topics from areas of geology, meteorology, astronomy and oceanography

Format: 75 multiple-choice items

Population: Students enrolled in an introductory college-level earth science course at the University of Northern Colorado

Reliability: $r = .858$ (K-R 20)
$N = 170$

Norms: $\overline{X} = 44.871$ (Control - posttest)
$N = 85$

Validation: Content validation by panel

Reference: Adams, Donald Karey. "An Experimental Comparison of a Lecture-Demonstration and Personalized Technique of Instructing a Large-Group General Education Earth Science Class." Unpublished doctoral dissertation, University of Northern Colorado, 1971, p. 89.
University Microfilms Order No. 72-3242

Title: EARTH SCIENCE ACHIEVEMENT TEST

Factors: Achievement in cognitive areas of traditional earth science course

Format: 75 multiple-choice items

Population: Ninth grade earth science students

Reliability: $r = .83$ (K-R 20) $N = 1002$

Norms: Means reported in dissertation

Validation: Items developed by earth science teachers. Trial with 121 earth science students provided item analysis information for final revision.

Reference: Agne, Russell M. "A Comparison of Earth Science Classes Taught by Using Original Data in a Research-Approach Technique Versus Classes Taught by Conventional Approach Not Using Such Data." Unpublished doctoral dissertation, University of Connecticut, 1970.Appendix.
University Microfilms Order No. 70-15,522

Title: STUDENT EARTH SCIENCE TEST

Factors: Earth science knowledge

Format: 40 multiple-choice items

Population: Junior high school students

Reliability: Not available

Validation: Items written and selected by science educators

Reference: Appendix p. 303

Title: [EARTH SCIENCE CONCEPTS TESTS]

Factors: Together the two tests measure achievement in each of 14 concepts in earth science

Format: Six to ten multiple-choice items on each concept. Test one has 73 items and test two has 52 items.

Population: Eighth and ninth grade students

Reliability:

Test 1	Test 2
r = .88 (K-R 20)	r = .83 (K-R 20)

Norms:

Test 1	Test 2
X = 41.82	29.07
S.D. = 10.86	7.68

(See page 44 of dissertation for data for each concept)

Validation: Content validity evaluated by panel

Reference: McNamara, Eugene Stephen. "A Comparison of the Learning Behaviors of Eighth and Ninth Grade ESCP Earth Science Students: One-Half Experiencing Laboratory Investigations in the Indoor Environment, the Other Half Experiencing Laboratory Investigations in the Outdoor Environment." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 145.

University Microfilms Order No. 72-13,895

Title: [EARTH SCIENCE TESTS]
1) Achievement Test
2) Unit Tests (4)

Factors: 1) Subject matter achievement (earth science)
2) Achievement in geology (2), meteorology, astronomy

Format: 60 multiple-choice items on each test

Population: Sophomore college students enrolled in physical science at SUNY College at Buffalo

Reliability: 1) r = .71 - .85 (K-R 20) N = 245
2) r = .70 - .82

Norms: 1) Post-test $\overline{X}$ = 29.64 (experimental)
2) Range $\overline{X}$ = 33.45 - 42.05 S.D. = 7.87 - 7.59 (experimental)
N = 119

Validation: Content validity determined by author

Reference: Young, Darrell Dean. "The Effects of Instruction Through Team Learning on Achievement in a General Education College Course in Physical Science." Unpublished doctoral dissertation, State University of New York at Buffalo, 1969, p. 60.
University Microfilms Order No. 69-15,195

Title: [CONCEPTS ON AIR PRESSURE]

Factors: Understanding of two concepts on air pressure at knowledge, comprehension and application levels.

Format: 23 multiple-choice items and 7 open-ended items

Population: Third and fifth graders

Reliability: r = .73 (Split-half)

Validation: Jury

Reference: Ryder, Exyie Mae Chambliss. "The Effects of Experience Background and an Advance Organizer on Elementary Pupils' Understanding of Selected Science Concepts." Unpublished doctoral dissertation, The University of Michigan, 1970, p. 102.
University Microfilms Order No. 71-23,864

Title: EARLY MAN IN AMERICA

Factors: Achievement in facts and concepts concerning early man

Format: 60 multiple-choice items

Population: Eighth-grade earth science students

Reliability: r = .85 (K-R 20) N = 143

Validation: Not available

Reference: Thomas, Barbara S. "An Analysis of the Effects of Instructional Methods Upon Selected Outcomes of Instruction in an Interdisciplinary Science Unit." Unpublished doctoral dissertation, University of Iowa, 1968, pp. 147-155.
University Microfilms Order No. 68-16,865

Title: [CHARTING THE EARTH TEST]

Factors: Achievement in the content of Chapter Four "Charting The Earth" from the text Charting the Universe developed by the Illinois Elementary School Science Project

Format: 55 multiple-choice items

Population: Sixth grade students

Reliability: r = .922 (K-R) N = 62

Norms: $\overline{X}$ = 26.0 S.D. = 11.7

Validation: 93 item test administered to forty students who had completed Chapter Four. Difficulty level and internal validity of instrument determined by item analysis.

Reference: Eaton, Edward J., Jr. "An Investigation of the Relationship of Three Factors in Printed Materials to Achievement in Astronomy by Sixth Grade Students." Unpublished doctoral dissertation, University of Illinois, 1964, pp. 135-186.
University Microfilms Order No. 65-3572

Title: TEST IN COLLEGIATE DESCRIPTIVE ASTRONOMY

Factors: Knowledge of those astronomy concepts which can be presented in a planetarium

Format: 40 multiple-choice items

Population: Students enrolled in a descriptive astronomy course in a Florida junior college

Reliability: r = .7441 (K-R 20)
Standard Error = 2.749
N = 225

Norms: $\bar{X}$ = 22.41
S.D. = 5.44

Validation: Content validation established by jury. Examiner's manual is available to standardize test administration.

Reference: Guilbert, Edward Hunt. "A Standardized Test in Collegiate Descriptive Astronomy on Selected Concepts which can be Demonstrated in the Planetarium." Unpublished doctoral dissertation, University of Southern Mississippi, 1972, p. 102.
University Microfilms Order No. 72-26,550

Title: [ASTRONOMY UNIT TEST] AND STANDARD ASTRONOMY TEST (SAT)

Factors: Achievement of facts and concepts in astronomy

Format: Multiple-choice items: 34 in unit test
65 in Standard Astronomy Test

Population: Students enrolled in a general education course in astronomy in a large midwestern university

	Unit Test	SAT
Reliability:	r = .32 (K-R 20) N = 110	r = .76 (K-R 20) N = 110
Norms:	$\bar{X}$ = 17.32 S.D. = 3.6	$\bar{X}$ = 17.14 S.D. = 5.73

Validation:	Not available
Reference:	Hoff, Darrel Barton. "A Comparison of a Directed Laboratory Versus an Inquiry Laboratory Versus a Nonlaboratory Approach to General Education College Astronomy." Unpublished doctoral dissertation, University of Iowa, 1970, p. 143. University Microfilms Order No. 70-23,898

Title:	CHARTING THE UNIVERSE TEST
Factors:	Achievement of concepts presented by Elementary School Science Project materials
Format:	37 multiple-choice items and five problems
Population:	Fifth grade students in a university laboratory school
Reliability:	r = .829 (K-R 20) N = 92
Norms:	$\overline{X}$ = 12.98 S.D. = 4.47 N = 90 (Post-test)
Validation:	Not available
Reference:	Klopfer, Leopold E. "An Evaluative Study of the Effectiveness and Effects of Astronomy Materials Prepared by the University of Illinois Elementary School Science Project." University of Chicago, Illinois, 1964. ED 032 221 MF $0.65 HC $3.29 59 pp.

Title:	[O[illegible]NES ASTRONOMY TESTS]
Factors:	Knowledge of selected astronomy concepts
Format:	Respondent completes a series of assessment tasks related to photographs and diagrams provided. Each task employs a multiple-choice response format.
Population:	Elementary astronomy students at Oklahoma State University.

Reliability: Not available

Validation: Content validity assumed as items were developed in reference to course objectives.

Reference: Oines, Ronald K. "The Comparative Effectiveness of Individually Prescribed Instruction and the Lecture Demonstration Method to Achieve Behavioral Objectives for a Descriptive Astronomy Course." Unpublished doctoral dissertation, Oklahoma State University, 1971, p. 85.
University Microfilms Order No. 72-21,960

Title: SELECTED ASTRONOMICAL PRINCIPLES TESTS (1 and 2)

Factors: Knowledge of concepts concerning 1) motion of stars, superior planets and the sun; 2) the celestial sphere and precession

Format: Multiple-choice items

Population: Students enrolled in a basic physical science course at West Chester State College (Pennsylvania)

Reliability: 1) r = .65 (K-R 21)   N = 758
2) r = .57 (K-R 21)

Validation: Content validity assessed through jury technique

Reference: Reed, George Francis. "A Comparison of the Effectiveness of the Planetarium and the Classroom Chalkboard and Celestrial Globe in the Teaching of Specific Astronomical Concepts." Unpublished doctoral dissertation, University of Pennsylvania, 1970, p. 87.
University Microfilms Order No. 71-6721

Title: ASTRONOMY TEST

Factors: Selected astronomy concepts

Format: 25 multiple-choice items

Population: Sixth grade students

Reliability: Not available

Norms: $\overline{X} = 14.21$ S.D. = 4.34 N = 5,131

Validation: Not available

Reference: Smith, Billy Arthur. "An Experimental Comparison of Two Techniques (Planetarium Lecture-Demonstration and Classroom Lecture-Demonstration) of Teaching Selected Astronomical Concepts to Sixth Grade Students." Unpublished doctoral dissertation, Arizona State University, 1966, pp. 59-65.
University Microfilms Order No. 66-6906

Title: TEST ON ASTRONOMY FACTS

Factors: Knowledge of astronomy facts

Format: 30 multiple-choice items

Population: College students enrolled in a survey of physics course

Reliability: Not available

Norms: $\overline{X} = 19.5$ and 21.4 N = 207

Validation: Content validity judged by author

Reference: Strope, Marvin B. "A Comparison of Factual and Conceptual Teaching in Introductory College Astronomy." Unpublished doctoral dissertation, Utah State University, 1966, pp. 45-54.
University Microfilms Order No. 65-13,869

Title: WHAT I KNOW ABOUT POLLUTION

Factors: Knowledge about problems of environmental pollution

Format: 50 multiple-choice items

Population: Fourth, fifth and sixth graders

Reliability: r = .78 (Split-half)

Validation: Jury

Reference: Holloway, Mildred Azelle Evans. "Cognitive and Affective Orientations of Elementary School Children Toward Air, Water, and Soil Pollution." Unpublished doctoral dissertation, University of Alabama, 1972, p. 269.
University Microfilms Order No. 72-17,107

Title: ENVIRONMENTAL PROBLEMS EXAMINATION

Factors: Knowledge of environmental problems

Format: 17 multiple-choice items

Population: Gifted high school students

Reference: Sikes, William Nick. "A Study of the Nature and Effectiveness of the Teaching of Environmental Problems to Gifted Science Students in Texas Public Schools." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 85.
University Microfilms Order No. 73-18,497

Title: CHECKLIST OF ENVIRONMENTAL CONCERNS

Factors: Opinions concerning environmental problems

Format: Respondents rank importance of environmental concerns in each of three areas; problem, responsibility for creating problems, and responsibility for solving problem

Population: High school teachers and students and college professors of environmental studies

Reference: Sikes, William Nick. "A Study of the Nature and Effectiveness of the Teaching of Environmental Problems to Gifted Science Students in Texas Public Schools." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p.112.
University Microfilms Order No. 73-18,497.

Title: GEOLOGICAL CONCEPTS TEST, GRADES 4, 5, 6

Factors: Understanding of selected geological concepts

Format: 44 multiple-choice items

Population: High and low achievers in grades four through six

Reliability: r = .84 (K-R 20) N = 293

Validation: Jury established content validity

Reference: Ashbaugh, Alexander C. "An Experimental Study for the Selection of Geological Concepts for Intermediate Grades." Unpublished doctoral dissertation, University of Georgia, 1964, pp. 94-103.
University Microfilms Order No. 65-4483

Title: GEOLOGY ACHIEVEMENT TEST

Factors: Achievement in geology content

Format: 99 multiple-choice items

Population: Students enrolled in introductory geology at The University of Oklahoma

Reliability: r = .89 (Split halves)

Norms: $\bar{X} = 32.69$ (out of 60 items only)
S.D. = 9.64
N = 516

Validation: Good construct validity indicated by t-values for each item coefficient; all being beyond the .001 level.

Reference: De Luca, Frederick Peter. "The Development and Implementation of Structured Inquiry Methods and Materials for an Introductory Geology Laboratory Course and Their Effectiveness as Compared with the Traditional Course." Unpublished doctoral dissertation, The University of Oklahoma, 1970, p. 158.
University Microfilms Order No. 71-12,564.

Title: TEST OF OCEANOGRAPHIC KNOWLEDGE

Factors: Oceanographic knowledge

Format: 37 multiple-choice items

Population: Pre-service elementary teachers from colleges in New York City

Reliability: $r = .69$
$N = 268$

Validation: Content validity established by one-member jury.

Reference: Flehinger, Lenore Edith. "Science Process Skill as a Predictor of Acquisition of Knowledge Among Pre-Service Teachers." Unpublished doctoral dissertation, Columbia University, 1971, p. 110.
University Microfilms Order No. 71-20,008

Title: TEST FOR SUPPLEMENTARY SOILS BLOCK

Factors: Achievement relating to analysis and interpretation of information covering soils and the retention of factual information on soils

Format: 50 multiple-choice items

Population: Junior high school students at Wilson Campus School, Mankato, Minnesota

Reliability: r = .811 (Hoyt) N = 97

Norms: $\bar{X}$ = 30.50
S.D. = 7.35

Validation: Face validity established by author

Reference: Kline, Arlyn Arthur. "A Study of the Relationship Between Self-Directed and Teacher-Directed Eighth Grade Students Involved in an Open-Ended ESCP Laboratory Block." Unpublished doctoral dissertation, University of Colorado, 1970, p. 195.
University Microfilms Order No. 70-23,728

Section 3: Physical Sciences

General Physical Science

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Mechanics Achievement Examinations	S	58
Miscellaneous Topics		
[Dimensional Analysis Test]	S	58
[Test on Kinetic Molecular Theory]	C	59
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[Relational Concepts Test]	S	60

Title: A PSNS INSTRUMENT

Factors: Knowledge of subject matter in modified Physical Science for the Nonscience Students program

Format: 21 multiple-choice items

Population: Freshmen at California State College, Pennsylvania

Reliability: r = .67 (Analysis of variance method developed by
N = 91 Hoyt and Stunkard)

Norms: Standard Error = 2.1075
X = 9.63 (Control group)

Validation: Items selected from the *Teacher's Resource Book* which accompanies the text *An Approach to Physical Science*. Selection validated by expert opinion (PSNS Staff).

Reference: Frangos, George John. "A Study of Three Outcomes of a College Level Course in Physical Science for Non-Science Students (Adapted PSNS)." Unpublished doctoral dissertation, The Ohio State University, 1971, p. 130.
University Microfilms Order No. 71-22,476

Title: [PSNS TESTS: ONE AND TWO]

Factors: Knowledge of content included in the PSNS course

Format: Test 1 - 100 multiple-choice items
Test 2 - 61 short answer items

Population: Non-science students at University of Northern Colorado, Greeley

Reliability: Test 1 r = .849 (K-R 20)
Test 2 r = .882 (Split-half)

Validation: Content validity assumed

Reference: Gunsch, Leonhardt Maurice. "A Comparison of Students' Achievement and Attitude Change Resulting from a Laboratory and Non-Laboratory Approach to General Education Physical Science Courses." Unpublished doctoral dissertation, University of Northern Colorado, 1972, p. 90.
University Microfilms Order No. 72-22,408

Title: A TEST OF GENERAL PHYSICAL SCIENCE

Factors: Achievement in physical science course content; knowledge of facts, concepts and principles.

Format: 50 multiple-choice items (two forms)

Population: Elementary education majors in Massachusetts State Teachers Colleges

Reliability: Several methods used yielded reliabilities on post-test ranging between .63 and .87.

Norms: $\bar{X} = 40.34$ (Post-test) S.D.=11.56 N = 884

Validation: Validation procedures used included; jury ratings of items, and the index of discrimination on items

Reference: Malone, William Howard. "The Construction and Use of a Test of Physical Science as it is Offered in the State Teachers Colleges of Massachusetts." Unpublished doctoral dissertation, Boston University, 1959, p. 126.
University Microfilms Order No. 60-313

Title: PHYSICAL SCIENCE TESTS

Factors: Knowledge of concepts on:
Test I Gravity
II Electricity and Magnetism
III Color concept attainment and comprehension of color related phenomena
IV Comprehensive

Format: Multiple-choice items; 35 in Test I, 41 in Test II, 50 in Test III, 100 in Test IV.

Population: Students enrolled in college physical science course at Bloomsburg State College, Pennsylvania.

Reliability: K-R 20 reliabilities; Test I r = .84, Test II r = .86, Test III r = .87, Test IV r = .81
N = 60

Validation: Jury

Reference: Scarpino, Tobias Fred. "The Comparative Effect of Two Strategies - Color Versus Black and White on Achievement in College Physical Science." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 97.
University Microfilms Order No. 72-13, 928

Title: PSNS TEST ITEMS

Factors: Content of first half of the course "An Approach to Physical Science" developed by the project Physical Science for the Non-Science Student

Format: Multiple-choice items

Population: College students enrolled in the PSNS course

Reliability: Each content area subtest had an $r = .70$ or greater (K-R 20)

Validation: Content validity established through face validity, sampling validity and logical validity techniques. Supportive evidence for construct validity was greater than non-supportive evidence.

Reference: Stroh, Ronald Richard. "The Development of a Bank of Test Items Having Content and Construct Validity for a College Level Physical Science Course." Unpublished doctoral dissertation, State University of New York at Buffalo, 1972, p. 124.
University Microfilms Order No. 72-15,634

Title: PHYSICAL SCIENCE SUBJECT MATTER TEST

Factors: Knowledge of facts and principles in physical science

Format: 59 multiple-choice items

Population: College sophomores enrolled in physical science

Reliability: $r = .85$ (Split-half technique using Spearman-Brown correlation)

Norms: $\bar{X} = 33.75$ S.E.=3.62 N = 362

Validation: Author selected and developed items with reference to course content. Two course instructors reviewed items for content validity, accuracy and clarity.

Reference: Zingaro, Joseph S. "An Experimental Comparison Between Two Methods of Teaching College Sophomores the Interrelationship of Physicochemical Principles in Physical Science." Unpublished doctoral dissertation, Syracuse University, 1965, p. 67.
University Microfilms Order No. 66-9873

Title: [CHEMISTRY INFORMATION TEST]

Factors: The level understanding of chemistry information; 1) Knowledge 2) Comprehension 3) Application 4) Analysis

Format: Reading passage followed by 45 multiple-choice items

Population: Students enrolled in high school chemistry

Reliabiltty: Not available

Norms: Listed on pp. 32-42 of dissertation (N's = 230 and 408)

Validation: Selection of items from Dressel and Nelson, _Questions and Problems in Science_ -- _Test Folio No. 1_; additional items developed by investigator. Reading passage and items submitted to panels of judges.

Reference: Anderson, June S. "A Comparative Study of Chemical Educational Material Study and Traditional Chemistry in Terms of Students' Ability to Use Selected Cognitive Processes." Unpublished doctoral dissertation, Florida State University, 1964, pp. 54-66.
University Microfilms Order No. 65-0309

Title: ACHIEVEMENT TESTS ON NUCLEAR CHEMISTRY

Factors: Two tests, each assesses achievement in nuclear chemistry

Format: 44 multiple-choice items

Population: High school chemistry students

Reliability: r = .841 and .882 (K-R 20)   N = 638

Validation: Face validity determined by five-member jury

Reference: Darnowski, Vincent S. "Three Types of Programmed Learning and the Conventional Teaching of the Nuclear Chemistry Portion of the High School Chemistry Course." Unpublished doctoral dissertation, New York University, 1968, p. 353.
University Microfilms Order No. 68-11785

Title: MATHEMATICS SKILL TEST FOR CHEMISTRY

Factors: Measures student performance at three cognitive levels on ten basic mathematics skills: computation, signed numbers, use of parentheses, fractions, decimals, exponents, percent, one-variable equations, ratio and proportions, and graphing.

Format: 60 multiple-choice items

Population: High school chemistry students

Reliability: r = .963 (K-R 20)   N = 272

Norms: $\overline{X}$ = 24.83   S.D. = 16.36   S.E. = .77

Validation: Judgemental validity by jury and item analysis. Concurrent validity by comparison with 1969 American Chemical Society High School Chemistry Test (r=.799).

Reference: See Appendix p. 192

Title: ONTARIO TEST OF ACHIEVEMENT IN CHEMISTRY

Factors: Achievement of cognitive objectives of knowledge, comprehension, application and analysis in chemistry

Format: Sixty multiple-choice items

Population: 12th grade chemistry students in college preparatory program of Ontario high schools

Reliability: r = .819 (K-R 20) N = 2339

Norms: $\overline{X}$ = 25.15 S.D. = 8.13

Validation: Not available

Reference: Even, Alexander. "Patterns of Academic Achievement in Grade 12 Chemistry and Their Relationship to Personal, Attitudinal and Environmental Factors." Toronto University, (Ontario) 1968, pp. 291-333.
ED 040 850 MF $0.65 HC $[illegible]6.45 421 pp.

Title: [TEST IN GENERAL CHEMISTRY]

Factors: Content achievement in general chemistry

Format: 100 multiple-choice items

Population: First quarter college chemistry students

Reliability: r = .84 (K-R 20) N = 120

Norms: $\overline{X}$ = 37.64 S.D. = 14.48 N = 701

Validation: Three member jury of professional chemists

Reference: Ledbetter, J. C. "The Effects of Instrumentation of Freshman Chemistry Laboratory on Achievement and Interest in Chemistry." Unpublished doctoral dissertation, Georgia University, Athens, 1969, pp. 232-264.
University Microfilms Order No. 70-1176

Title: ACHIEVEMENT TEST FOR MEASURING SCIENCE CONCEPTS (FORMS A AND B)

Factors: Achievement in concepts of elementary chemistry

Format: A variety of objective items are used but multiple-choice items predominate.

Population: Fifth graders

Reliability: Not available

Norms: See dissertation

Validation: Not available

Reference: Marshall, Robert Bruce. "Three Methods of Science Instruction Using Fifth Level Students in a Non-Graded Elementary School." Unpublished doctoral dissertation, The University of Tennessee, 1970, p. 134.
University Microfilms Order No. 71-7659

Title: [CHEMISTRY TEST]

Factors: Subject matter achievement in chemistry

Format: 30 multiple-choice items

Population: Students in secondary schools in Beirut, Lebanon

Reliability: Not available

Norms: $\bar{X} = 17.08$ $N = 22$

Validation: CHEM Study achievement tests used as guide in development. Results of trial submitted to three-person panel for revision.

Reference: Namek, Yakub Rizkallah. "The Effect of Integrated Laboratory Work on Achievement in Secondary School Chemistry." Unpublished doctoral dissertation, The University of Wisconsin, 1968, pp. 153-166.
University Microfilms Order No. 68-5339

Title: GENERAL CHEMISTRY EXAMINATION

Factors: Achievement and problem-solving ability in chemistry

Format: 70 true-false items and 10 multiple-choice items

Population: College general chemistry students

Reliability: r = .72 (Split-halves technique using Spearman-Brown correction formula) N = 149

Norms: Experimental group: $\overline{X}$ = 32.81 S.E. = .85 N = 73

Validation: Content validity estimated from normal distribution of test scores, examination of test by author and two chemistry professors and correlation with American Chemical Society Problem-Solving Examination.

Reference: Riggs, Virgil M. "A Comparison of Two Methods of Teaching College General Chemistry Laboratory." Unpublished doctoral dissertation, Oklahoma State University, 1961, pp. 138-147.
University Microfilms Order No. 62-1620

Title: [CHEMISTRY EXAMINATIONS (7)]

Factors: Performance in chemistry at various cognitive levels

Format: Each test has the following multiple-choice items: 15 analogy, 10 knowledge level, 10 comprehension level, 5 application level, 5 analysis level, 5 evaluation level

Population: College-level chemistry students

Reliability: r = .75 to .88 (K-R 21)

Validation: Content and curriculum validity established by experts

Reference: Talley, Lawrence Horace. "The Use of Three Dimensional Visualization as a Moderator in the Higher Cognitive Learning of Concepts in College-Level Chemistry." Unpublished doctoral dissertation, West Virginia University, 1972, p. 82.
University Microfilms Order No. 72-26,854

Title: CONCEPTS OF CHEMISTRY LABORATORY EXAMINATION

Factors: Knowledge of chemistry

Format: 20 multiple-choice items

Population: College chemistry students at Western Connecticut State College

Reliability: r = .82 (Split-half)

Validation: Jury

Reference: Uricheck, Michael James. "The Effect of Verbal Interaction on the Achievement of Specific Skills in the Introductory College Chemistry Laboratory: . . ." Unpublished doctoral dissertation, New York University, 1971, p. 143.
University Microfilms Order No. 71-24,818

Title: [CHEMICAL CONCEPTS TESTS]

Factors: Application of chemical concepts

Format: 25 to 40 items; multiple-choice or true-false

Population: High school chemistry students, not science oriented, probably not college-bound

Reliability: r = .66 (Test-retest of two of the instruments using Pearson-Product-Moment Correlation) N = 20

Norms: $\overline{X}$ = 26 (out of 40 items) S.D. = 5.42
Final exam, experimental group

Validation: Not available

Reference: Walton, George. "A Small Project Research Proposal in Secondary School Science Education." Western New Mexico University, 1968. (Tests at end of document.)
ED 023 614 MF $0.65 HC $13.16 391 pp.

Title: MATHEMATICS-PHYSICS SURVEY EXAMINATION

Factors: The use of mathematical skills in solving physics problems; 1) linear equations, 2) inverse equations, 3) inverse square equations, 4) vector solution, 5) equations involving trigonometric relations, 6) graph interpretation, 7) standard notation, 8) simultaneous equations

Format:
Section A: 20 physics problems involving the use of mathematical skills
Section B: 20 similar problems with appropriate formula following each item
Section C: 15 mathematical problems involving skills required in Sections A and B

Population: Secondary school physics students in New York State schools

Reliability: $r = .756$ (Spearman-Brown using split-half technique)
$N = 56$

Norms:
A. $\bar{X} = 14.848$ S.D. = 3.562
B. $\bar{X} = 16.036$ S.D. = 3.257 $N = 362$
C. $\bar{X} = 13.420$ S.D. = 1.370

Validation: Content validity established by five-person jury

Reference: Abeles, Sigmund. "The Utilization of Certain Mathematical Skills in the Solution of Selected Problems in Physics." Unpublished doctoral dissertation, New York University, 1966, p. 168.
University Microfilms Order No. 67-107

Title: [PHYSICS TESTS]

Factors: Achievement in physics

Format: 40 to 45 multiple-choice items in each test

Population: College physics students

Reliability: $r = .87$ to $.92$ (Split-halves method using Spearman-Brown Prophecy Formula)

Validation: Not available

Reference: Abrams, Leonard S. "A Comparison of the Teaching Effectiveness of Some Methods of On-Campus Supplementation of the Telecourse Atomic Age Physics." Unpublished doctoral dissertation, New York University. 1958, pp. 115-126.
University Microfilms Order No. 62-1459

Title: THEORY TEST IN PHYSICS

Factors: Knowledge of facts, principles and generalizations of physics

Format: Item types include multiple-choice, completion and true-false

Population: Students enrolled in a one-semester terminal physics course at Wisconsin State College in Stevens Point

Reliability: r = .88 (Split-half method using Spearman-Brown)
N = 49

Norms: $\overline{X}$ = 69.35 S.D. = 11.13

Validation: Not available

Reference: Bainter, Monica E. "A Study of the Outcomes of Two Types of Laboratory Techniques Used in a Course in General College Physics for Students Planning to be Teachers in the Elementary Grades." Unpublished doctoral dissertation, The University of Wisconsin, 1955, p. 248.
University Microfilms Order No. 14,680

Title: LABORATORY PERFORMANCE AND LABORATORY THEORY TEST

Factors: Knowledge of facts, generalization and principles of physics. Two factors identified; theory and performance.

Format: Practical examination with variable format including multiple-choice items

Population: Students enrolled in a terminal one-semester physics course at Wisconsin State College - Stevens Point

Reliability: Theory $r = .73$ (Split-half technique using Spearman-Brown formula)
Performance $r = .54$ $N = 49$

Norms: Theory $\bar{X} = 23.25$ $r = 4.14$
Performance $X = 23.22$ $r = 5.12$

Validation: Not available

Reference: Bainter, Monica E. "A Study of the Outcomes of Two Types of Laboratory Techniques Used in a Course in General College Physics for Students Planning to be Teachers in the Elementary Grades." Unpublished doctoral dissertation, The University of Wisconsin, 1955, p. 259.
University Microfilms Order No. 14,680

Title: ACHIEVEMENT TESTS IN PHYSICS (ENGLISH AND SPANISH VERSIONS)

Factors: Test 1. Motion in one dimension
Test 2. Motion in a plane
Test 3.and 4. Dynamics
Test 5.and 6. Work and Energy
Test 7. Conservation of linear momentum
Test 8. Rotational motion and angular momentum

Format: Each of the eight tests consists of 20 multiple-choice items

Population: College students from Latin America studying at the University of Texas

Reliability: (All with K-R 20)

Test	Spanish	English
1.	.77	.82
2.	.76	.72
3.	.58	.82
4.	.74	.67
5.	,62	.77
6.	.76	.65
7.	.70	.67
8.	.81	.71

Validation: Tests developed in English at the University of Texas validated for content by university faculty and then translated into Spanish.

Reference: Cooper, Clarence Henry. "An Analysis of Instruction in Spanish and in English Using Materials Developed for Teaching Physics to Latin American College Students." Unpublished doctoral dissertation, The University of Texas at Austin, 1971, p. 132.
University Microfilms Order No. 72-15,733

Title: A TEST OF ABILITY TO IDENTIFY AND APPLY SELECTED PRINCIPLES OF PHYSICS

Factors: See Title

Format:
Part I: For each of 19 items a principle is stated followed by an event or phenomenon (situation). Student selects the one of four responses which represents the correct application of the principle.
Part II: Situation is described, student selects principle which is the major cause or explanation for the situation.

Population: 12th grade students

Reliability: Part I: r = .637 (K-R 20) Part II: r = .719 (K-R 20)
N = 4434

Norms:
Part I: $\overline{X} = 8.5$ (19 items)
Part II: $\overline{X} = 10$ (17 items)

Validation: Content validity determined by panel of judges

Reference: See Appendix p. 201.

Title: PHYSICS TEST I

Factors: Recall, recognition and understanding of physics content

Format: 40 multiple-choice items

Population: College freshmen

Reliability: r = .743 (Split-halves method using Spearman-Brown formula)
N = 211

Validation: Content validity by jury. Concurrent validity by comparison with standardized test results and teacher grades.

Reference: Sandler, Barney. "A Comparison of an Integrated Course in College Physics and Mathematics of one Semester Duration with Separate Courses in the Two Subjects in a Two Year Community College." Unpublished doctoral dissertation, New York University, 1961, p. 82.
University Microfilms Order No. 62-1429

Title: PHYSICS TEST

Factors: Knowledge of physics

Format: 2 forms each consisting of 30 multiple-choice items

Population: Male high school students from the Stanford University area

Reliability: Internal consistency coefficient alpha
Form A = .69
Form B = .74
Intertest correlation r = .58

Validation: Not available

Reference: Shavelson, Richard Joseph. "Some Aspects of the Relationship Between Content Structure and Cognitive Structure in Physics Instruction." Unpublished doctoral dissertation, Stanford University, 1971, p. 143.
University Microfilms Order No. 71-19,759

Title: CHEMISTRY OF FIRE

Factors: Knowledge, translation, interpretation and extrapolation of information on the "chemistry of fire"

Format: 99 multiple-choice items

Population: Seventh grade

Reliability: Ranges from .542 to .701 (K-R 20)
N = 89

Norms: Means given by subtest, page 60 of dissertation

Validation: Not available

Reference: Andriette, William Rudolf. "Differences Between Populations of Seventh Grade Science Students Taught by Two Methods of Instruction: Small Group Laboratory and Teacher Demonstration." Unpublished doctoral dissertation, Syracuse University, 1970, Appendix.
University Microfilms Order No. 70-24,062

Title: [LIGHT TEST]

Factors: Knowledge, translation, interpretation and extrapolation of information concerning the concept "light"

Format: 90 multiple-choice items

Population: Seventh grade science students

Reliability: Range from .524 to .622 (K-R 20)
N = 54

Norms: Means given by subtest, page 61 of dissertation

Validation: Not available

Reference: Andriette, William Rudolf. "Differences Between Populations of Seventh Grade Science Students Taught by Two Methods of Instruction: Small Group Laboratory and Teacher Demonstration." Unpublished doctoral dissertation, Syracuse University, 1970, p. 74.
University Microfilms Order No. 70-24, 062

Title: THE TEST OF ELECTROSTATICS CONCEPTS

Factors: Achievement in additive and multiplicative classification seriation and electrostatics concepts

Format: Practical test with 30 Piagetian-like tasks

Population: Third grade students from high socioeconomic area

Reliability: Not available

Validation: Not available

Reference: Bridgham, Robert G. "Classification, Seriation, and the Learning of Electrostatics." *Journal of Research in Science Teaching*, Vol. 6, pp. 118-127, 1969

Title: ELECTRICITY AND MAGNETISM

Factors: Understanding of concepts presented in problem-solving situations

Format: 102 multiple-choice items matching ink drawings to vocabulary items

Population: Fifth and sixth grade students

Reliability: $r = .90$ (Split-halves method using Pearson product-moment)

Norms: $\overline{X} = 62.9$ to 67.0

Validation: Face validity established by four-member jury

Reference: Brudzynski, Alfred John. "A Comparative Study of Two Methods for Teaching Electricity and Magnetism with Fifth and Sixth Grade Children." Unpublished doctoral dissertation, Boston University, 1966, pp. 174-184.
University Microfilms Order No. 66-14,766

Title: [CONCEPTS OF LIGHT]

Factors: Application of concepts included in the topic "Light"

Format: 26 situation-based multiple-choice items

Population: Secondary school students in the country of Tanzania

Reliability: r = .81 (Odd-even split-half technique)
N = 162

Norms: Not available - administered to over 500 students

Validation: Five-member panel of judges

Reference: Cannon, George H. "Relationships of Certain Characteristics of African Learners to Achievement in Programmed Instruction." Unpublished doctoral dissertation, Washington State University, 1968, p. 85.
University Microfilms Order No. 68-10,949

Title: PHYSICAL SCIENCE TEST OVER HEAT AND TEMPERATURE

Factors: Understanding and application of knowledge about heat and temperature

Format: 60 multiple-choice items

Population: Eighth grade students enrolled in physical science classes

Reliability: Reliability coefficient of 88.6 computed from results of test administered to 110 ninth grade students.

Norms: $\overline{X}$ = 41.00 (Post-test)
N = 96

Validation: Items selected from a variety of materials by two teachers and the researcher

Reference: Clark, Billy M. "An Experiment in Cultivating Creative Thinking Abilities in the Classroom." Unpublished doctoral dissertation, Iowa State University, 1968, pp. 85-92.
University Microfilms Order No. 68-14,778

Title: TEST ON UNDERSTANDING RADIOACTIVITY

Factors: Understanding of the principles and applications of radioactivity

Format: 24 item multiple-choice test

Population: Undergraduate students of the University of Texas at Austin

Reliability: r = .82 (Split-halves)

Validation: Judges selected items from pool. Final selection for instrument made on basis of discrimination index. Empirical validity also established.

Reference: Crater, Harold L., Jr. "The Identification of Factors Influencing College Students' Attitudes Toward Radioactivity." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 79.
University Microfilms Order No. 73-7537

Title: ENERGY: TEST ONE

ENERGY: TEST TWO

Factors: Knowledge of energy concept

Format: A series of pictures representing different forms of energy. Student is to indicate which form,if any,is represented

Population: Second grade students in Ithaca, New York

Reliability: r = .75 (Test-retest)

Validation: Face validity

Reference: McClelland, John Andrew Gerald. "An Approach to the Development and Assessment of Instruction in Science at Second Grade Level: The Concept of Energy." Unpublished doctoral dissertation, Cornell University, 1970, p. 165.
University Microfilms Order No. 71-12,134

Title: UNIT TEST - ELECTRICITY

Factors: Content achievement in facts and concepts concerning electricity

Format: 65 multiple-choice items

Population: 4th, 5th and 6th grade students

Reliability: Experimental groups: r = 0.84 (Kuder-Richardson "rational equivalence" method)
N = 60

Norms: Post-test experimental group, 6th grade $\overline{X} = 45.95$

Validation: 14-member jury established content validity

Reference: Pershern, Frank R. "The Effect of Industrial Arts Activities on Science Achievement and Pupil Attitudes in the Upper Elementary Grades." Unpublished doctoral dissertation, Texas A & M University, 1967, pp. 126-149.
University Microfilms Order No. 68-9802

Title: [TEST ON HEAT AND SOUND]

Factors: Knowledge of heat and sound; subtests:
1. Mathematical characteristics
2. Practical applications
3. Logical extrapolation of principles
4. Recall of class material

Format: Multiple-choice items
1. 30
2. 29
3. 36
4. 35

Population: Students enrolled in St. Paul (Minnesota) Technical Vocational Institute

Reliability: (Hoyt)
Total r = .869
1. r = .683
2. r = .658
3. r = .718
4. r = .759

Validation: Face validity

Reference: Richter, George B. "A Comparison of an Independent-Progress-Rate Method with an Even Front Method in the Teaching of Science." Unpublished doctoral dissertation, University of Minnesota, 1972, p. 95.
University Microfilms Order No. 72-27,797

Title: FARM ELECTRIFICATION (TEACHER AND STUDENT FORMS)

Factors: Achievement in basic principles of electricity applied to farm and home

Format: 50 multiple-choice items on student form, 60 on teacher form

Population: 12th grade students of vocational agriculture in Spring Mills, Pennsylvania and in-service teachers of agriculture

Reliability: Not available

Norms: See dissertation

Validation: Not available

Reference: Wilson, Russell Charles. "Effectiveness of Teaching Electricity to High School Students by Varied Class Time Sequences and Teaching Materials." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 95.
University Microfilms Order No. 71-28,741

Title: [PARTICLE NATURE OF MATTER]

Factors: Test items were developed related to 25 selected concepts from the scheme, "the particle nature of matter."

Format: Items were of alternate response pictorial type, presented via motion picture film. Five items were developed for each concept. The verbal part of each question was read aloud while student viewed the written question and picture on the screen and in test booklets.

Population: Each item used at all grade levels 2-6

Validation: Items designed to reduce demand on reading and verbal ability of students

Reference: Doran, Rodney Lee. "Development of Test Items Related to Selected Concepts Within the Scheme the Particle Nature of Matter." Unpublished doctoral dissertation, University of Wisconsin, 1969, pp. 129-139.
University Microfilms Order No. 70-3515

Title: SEVENTH GRADE MATTER FINAL

Factors: Achievement of facts and concepts of matter

Format: 50 multiple-choice items

Population: Seventh grade students of a university school

Reliability: r = .70 (K-R) N = 54

Norms: $\bar{X}$ = 23.09 S.D. = 2.96

Validation: Face validity

Reference: James, Robert K. "A Comparison of Group and Individualized Instructional Techniques in Seventh Grade Science." Unpublished doctoral dissertation, University of Iowa, 1969, pp. 108-118.
University Microfilms Order No. 69-21,698

Title: [ELEMENTARY ATOMIC STRUCTURE]

Factors: Achievement in elementary atomic structure

Format: 30 multiple-choice items

Population: Eighth-grade general science students of middle class background

Reliability: r = .73 (K-R 20) N = 769

Validation: Eight-member jury of chemical educators

Reference: Knorr, Sheldon H. "A Charge Cloud Atomic Model for Junior High School Students." Unpublished doctoral dissertation, University of Maryland, 1967, pp. 184-190.

University Microfilms Order No. 68-6533

Title: MATTER, ATOMS, AND MOLECULES

Factors: Recall and application of content - from a unit on matter, atoms and molecules

Format: 60 multiple-choice items split between two subtests; recall and application

Population: Ninth grade physical science students

Reliability: r = .936 (K-R 20) N = 547

Norms: Means for three treatment groups ranged from 35.06 - 38.62

Validation: Three-member jury

Reference: McKee, Ronald J. "A Comparative Study of Two Programmed Instructional Methods and Conventional Instruction in a Unit of Ninth Grade Physical Science." Unpublished doctoral dissertation, University of North Dakota, 1966, p. 92.

University Microfilms Order No. 67-4466

Title: HARVARD PROJECT PHYSICS TEST - TEST C

Factors: Achievement in knowledge of the atom

Format: 40 multiple-choice items

Population: High school students from various parts of the United States

Reliability: $r = 0.798$ (Split-half)

Validation: Content validity assumed as items were supplied by group of experts selected from Harvard Project Physics Test groups

Reference: Schneiderwent, Myron Otto. "The Effects of Using Behavioral Objectives in the Instruction of Harvard Project Physics." Unpublished doctoral dissertation, University of Northern Colorado, 1970, p. 80.
University Microfilms Order No. 71-4211

Title: [TEST ON THE PARTICLE NATURE OF MATTER]

Factors: Knowledge of concepts selected from the concept scheme; the particle nature of matter

Format: Two multiple-choice items for each of 30 concepts were constructed; one verbal and one pictorial

Population: Midwestern elementary school; grades 1 - 6 on items 1-32, grades 3 - 6 only on remainder

Reliability: $r = .72$ (32 items) Hoyt
$r = .81$ (60 items) Hoyt

Norms:

	32 items	60 items
$\bar{X}$	=22.89	40.32
S.D.	= 4.39	7.58
N	= 498	297

Validation: Each item evaluated against four "adequacy" criteria

Reference: Smith, Carson Vincent. "The Feasibility and Relative Effectiveness of Specialist and Classroom Teachers Utilizing Large-Group Instructional Techniques in Teaching Selected Science Concepts to Elementary School Children." Unpublished doctoral dissertation, The University of Wisconsin, 1970, p. 259.
University Microfilms Order No. 70-22,673

Title: MACHINE PRINCIPLES TESTS (I, II and III)

Factors: Knowledge of simple machine concepts

Format: Tests I & II: 34 items; multiple-choice, true-false
and application
Test III: 29 verbal-pictorial items

Population: Sixth grade students

Reliability:

	Test I	Test III
N =	300	300
r =	.86	.85

Norms: See p. 70 of dissertation

Validation: Jury

Reference: Pagano, Arnold Robert. "A Comparison of the Effects of Four Teaching Strategies on the Acquisition, Retention, and Transfer of Selected Science Concepts in the Sixth Grade." Unpublished doctoral dissertation, University of California, Berkeley, 1970, p. 165.
University Microfilms Order No. 71-9745

Title: UNIT TEST - MACHINES

Factors: Content achievement in facts and concepts concerning machines

Format: 65 multiple-choice items

Population: 4th, 5th and 6th grade students

Reliability: Experimental groups: r = 0.84 (Kuder-Richardson "rational equivalence" method)
N = 60 in each group

Norms: Post-test experimental groups: $\bar{X}$ (4th grade) = 35.08
$\bar{X}$ (5th grade) = 38.70
$\bar{X}$ (6th grade) = 42.85

Validation: 14-member jury established content validity

Reference: Pershern, Frank R. "The Effect of Industrial Arts Activities on Science Achievement and Pupil Attitudes in the Upper Elementary Grades." Unpublished doctoral dissertation, Texas A & M University, 1967, pp. 126-149.
University Microfilms Order No. 68-9802

Title: MECHANICS ACHIEVEMENT EXAMINATION

Factors: Achievement in mechanics; used as a predictor of success in physics

Format: 50 multiple-choice items

Population: Eleventh graders at Bronx High School of Science

Reliability: $r = .87$ (K-R 20) $N = 127$

Norms: $\bar{X} = 60.968$ $N = 124$

Validation: Item analysis of entire item pool produced indices of discrimination and difficulty. Items for final test form were selected from those close to the 50% level of difficulty and exceeding 0.20 in discrimination. This form was then modified on the basis of a second item analysis and jury recommendations.

Reference: Vandecker, Louis. "The Effect of Delayed-Response Learning Guides and Immediate Response Teaching Tests on Achievement in Mechanics." Unpublished doctoral dissertation, New York University, 1968, pp. 161-171.
University Microfilms Order No. 69-21,192

Title: [DIMENSIONAL ANALYSIS TEST]

Factors: Knowledge of dimensional analysis

Format: 62 multiple-choice items

Population: High school physics students

Reliability: $r = .91$ (Hoyt)
$N = 72$

Norms: See p. 23 of dissertation

Validation: Not determined

Reference: Schmitz, Francis Leo. "A Comparison of the Relative Effectiveness of Utilizing Two Types of Student Participation in Laboratory Activities in Teaching Dimensional Analysis in High School Physics." Unpublished doctoral dissertation, The University of Wisconsin, 1970, p. 177.
University Microfilms Order No. 70-22,668

Title: [TEST ON KINETIC MOLECULAR THEORY]

Factors: Knowledge and understanding of kinetic molecular theory

Format: 30 multiple-choice items

Population: Students enrolled in a college-level general education course in chemistry

Reliability: $r = .47$ (Test-retest)
$r = .81$ (Split-halves)

Norms: $\bar{X}$ (male) = 20.4
$\bar{X}$ (female) = 19.7

Validation: Jury

Reference: Ault, Frederick Keith. "Cognitive Style, Attitude Toward Science, and Sex on Success with Programmed Instruction on Kinetic Theory." Unpublished doctoral dissertation, Indiana University, 1970, p. 123.
University Microfilms Order No. 71-11,361

Title: ASSESSMENT OF CONCEPT ATTAINMENT: REFRACTION

Factors:
1) Concept Attainment Test - Use of knowledge of "refraction" in solving problems.
2) Concept Knowledge Test - Amount of knowledge of the concept.

Format:
1) 30 multiple-choice items
2) 24 multiple-choice items

Population: High school physics students in Pittsburgh, Pennsylvania

Reliability: Not available $N = 484$

Validation: Content validity established by jury

Reference: Cunningham, James Barrett. "The Measurement of Concept Attainment: A Comparative Study of Modern and Traditional High School Physics Courses." Unpublished doctoral dissertation, Syracuse University, 1970, p. 99.
University Microfilms Order No. 71-18,476

Title: [RELATIONAL CONCEPTS TEST]

Factors: Knowledge of relational concepts normally taught in secondary school physics

Format: Quasi-nonverbal, with 73 pairs of stimulus-response photographic slides using four-option multiple-choice response format

Population: Secondary school physics students

Reliability: r = .726 (K-R 20)
N = 226

Validation: Curricular and construct validity established

Reference: (Test not included)
Podrasky, Edward Francis. "The Development and Validation of a Quasi-Nonverbal Test for Measuring Attainment of Relational Concepts in High School Physics." Unpublished doctoral dissertation, The Pennsylvania State University, 1970, Appendix.
University Microfilms Order No. 71-16,652

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Title: PHYSICAL SCIENCE 114 LABORATORY EXAMINATION

Factors: Achievement in general science topics

Format: 27 multiple-choice items and one short answer problem

Population: Freshmen and sophomore college non-science majors

Reliability: r = .64 (K-R 20) N = 60

Validation: Determination of internal consistency

Reference: Appleman, Ronald E. "A Comparative Study of the Cognitive Effects of the Use of Take Home Laboratory Materials on Student Achievement in College Level Physical Science Classes." Unpublished doctoral dissertation, Oklahoma State University, 1967, p. 52.
University Microfilms Order No. 68-8692

Title: TEACHER CONTENT TEST

Factors: Knowledge of concepts of change and continuity

Format: 34 multiple-choice items

Population: Elementary teachers in Seattle public schools

Reliability: r = .61 (K-R 20) N = 54

Validation: Constructed with reference to objectives of TV science program. Items rated by teachers as to appropriateness; 95% agreement.

Reference: Beisenherz, Paul Chambers. "An Experimental Study of a Televised Science Series, Grades 1-4, Comparing the Quality and Sequence of Television and Classroom Questions with a Proposed Strategy of Science Instruction." Unpublished doctoral dissertation, University of Washington, 1971, p. 248.
University Microfilms Order No. 72,7319

Title: THE SCIENCE FROM CONCEPTS ACHIEVEMENT TEST

Factors: Achievement in science concepts commonly taught in elementary school

Format: 64 multiple-choice items

Population: College undergraduate majors in elementary education

Reliability: r = .723 (K-R 20) N = 215

Norms: $\overline{X}$ (Control pre-test) = 37.63
Standard Error = 3.43

Validation: Content validity established by jury and a survey of elementary science textbooks

Reference: Christman, Hugh Gene. "An Evaluation of Elementary Science Content and Elementary Teaching Methods in Science Courses at The Pennsylvania State University." Unpublished doctoral dissertation, The Pennsylvania State University, 1970, p. 95.
University Microfilms Order No. 71-16,585

Title: GENERAL SCIENCE KNOWLEDGE

Factors: Knowledge of general science concepts

Format: 30 multiple-choice items. Respondent indicates his degree of certainty that he has selected the correct response.

Population: Students in professional education classes.

Reliability: r = 0.680 (K-R 20) N = 60

Norms: $\overline{X}$ = 7.02 S.D. = 2.73

Validation: Not available

Reference: Gilman, David A. "A Comparison of the Effectiveness of Feedback Modes for Teaching Science Concepts by Means of a Computer-Assisted Adjunct Auto-Instruction Programs." Unpublished doctoral dissertation, The Pennsylvania State University, 1967, pp. 109-116.
University Microfilms Order No. 68-8692

Title: [EXAMINATION IN SCIENCE]

Factors: Achievement in diverse science topics

Format: Completion, multiple-choice and essay items (2 forms)

Population: College non-science majors

Reliability: Not available

Validation: Not available

Reference: Leader, William. "The Expressed Science Interests of Students at the Conclusion of a College Science Survey Course and Their Relationship to Achievement in the Course." Unpublished doctoral dissertation, Columbia University, 1951, pp. 81-98.
University Microfilms Order No. 3357

Title: PORTLAND SCIENCE TEST

Factors: Knowledge of products of science and understanding and ability to use processes of science

Format: 60 multiple-choice items in product-process pairs

Population: Eighth grade students in Portland from a variety of backgrounds

Reliability: $r = 0.85$ (Garrett rational equivalence method)
$N = 515$

Norms:
Experimental group $N = 262$
Process $\bar{X} = 16.2$ S.D. $= 4.65$
Product $\bar{X} = 16.6$ S.D. $= 5.50$
Total $\bar{X} = 32.8$ S.D. $= 9.59$

Validation: Jury of all Portland ninth grade science teachers

Reference: Hutchinson, John S. "Automated Science Curriculum: An Experimental Science Program." Unpublished doctoral dissertation, Oregon State University, 1966, pp. 123-160.
University Microfilms Order No. 67-716

Title: SCIENCE SKILLS TEST

Factors: Spelling, vocabulary, reading comprehension and total achievement in science

Format: 70 to 100 multiple-choice items in each of four sub-tests

Population: Eighth grade biology students

Reliability: r = .73 to .94 (Split-halves on sub-tests)
N = 166

Validation: Not available

Reference: Jones, John L. "Effects of Spelling Instruction in Eighth-Grade Biological Science Upon Scientific Spelling, Vocabulary, and Reading Comprehension: General Spelling, Vocabulary, and Reading Comprehension: Science Progress: and Science Achievement." University of Maryland, 1966, pp. 67-120.
University Microfilms Order No. 67-6121

Title: TEACHER-MADE SUBJECT-MATTER TESTS

Factors: Content achievement in general science;
1) Living things
2) Simple machines
3) Airplanes
4) Electricity and magnetism
5) Chemistry
6) Geology

Format: Completion, multiple-choice and true-false items; the six tests total 215 items

Population: Eighth grade students

Reliability: Method not reported

1) r = .70   4) r = .55
2) r = .76   5) r = .91   N = 56
3) r = .57   6) r = .84

Norms:
1) $\bar{X} = 23.59$ S.D. = 5.47
2) $\bar{X} = 11.98$ S.D. = 4.24
3) $\bar{X} = 19.54$ S.D. = 3.22
4) $\bar{X} = 21.37$ S.D. = 3.70
5) $\bar{X} = 28.35$ S.D. = 12.50
6) $\bar{X} = 29.07$ S.D. = 8.15

Validation: Validity indices range from .74 to .95 on subtests. Method of determination not given.

Reference: Jones, Kenneth W. "A Comparison of Two Methods of Teaching Eighth Grade General Science: Traditional and Structured Problem Solving." Unpublished doctoral dissertation, The University of Arizona, 1966, p. 126.
University Microfilms Order No. 66-10,201

Title: JUNIOR HIGH SCIENCE ACHIEVEMENT TEST

Factors: Achievement of science vocabulary

Format: 116 matching and discrimination items

Population: Ninth grade science students from suburban schools

Reliability: $r = .889$ (Split-halves technique using Spearman-Brown formula)
$N = 593$

Norms: $\bar{X} = 65.50$ S.D. = 13.54

Validation: Correlations with: Read General Science Test .740; Teacher grades .615; Terman-McNemar Test of Mental Ability .606.

Reference: Lazow, Alfred. "The Construction of a Junior High Science Achievement Test Based on a Vocabulary Selected from Current Science Textbooks." Unpublished doctoral dissertation, Boston University School of Education, 1964, pp. 104-122.
University Microfilms Order No. 65-5531

Title: QUALITY CONCEPT INVENTORY OF TWENTY SELECTED SCIENCE WORDS

Factors: Level of comprehension of the twenty science words expressing concepts having various degrees of complexity

Format: Two forms, senior high school and junior high school. Both contain three true statements on each of twenty words. For each statement respondents are asked to indicate agreement, disagreement or indecision (Part I). Respondents are then asked to rank each of the three statements associated with a word according to their importance (Part II).

Population: Junior and senior high school children in Colorado schools

Reliability: Part I: r = .83 (junior high form) and .80 (senior high form) K-R 20

Part II: reliability coefficients for average rankings ranged above .88 except for one word on junior high form.

Norms: Not available. Given to 5,713 students

Validation: Jury assessed validity of statements and ranked them according to complexity. Reliability coefficient for rankings ranged above .90 for all 20 sets of statements.

Reference: Shoemaker, Joseph Leslie. "A Study of the Differences of Comprehension that Pupils in Colorado Secondary Schools Have of Twenty Selected Science Words." Unpublished doctoral dissertation, University of Colorado, 1963, pp. 150-166.
University Microfilms Order No. 64-1943

Title: PRINCIPLES OF SCIENCE EXAMINATION

Factors: Knowledge of science principles

Format: 83 multiple-choice items

Population: Gifted high school students

Reference: Sikes, William Nick. "A Study of the Nature and Effectiveness of the Teaching of Environmental Problems to Gifted Science Students in Texas Public Schools." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 89.
University Microfilms Order No. 73-18,497

Title: [EQUILIBRIUM TEST]

Factors: Knowledge and understanding of the concept of equilibrium; ability to use concept as a first level cognitive "organizer."

Format: Single response, four-choice objective style, 54 items

Population: Seventh and ninth grade students

Reliability: $r = .60$ (Analysis of variance)

Norms: $\overline{X} = 19.14$ S.D. = 5.2

Validation: Not available

Reference: Triezenberg, Henry J. "The Relative Effectiveness of Three Levels of Abstraction Representing the Conceptual Scheme of Equilibrium as an Advance Organizer in Teaching." Unpublished doctoral dissertation, University of Wisconsin, 1967, p. 304.
University Microfilms Order No. 67-17040

Title: SCIENCE CONCEPTS TEST, GRADES 3 AND 4

Factors: Knowledge of concepts of change and continuity

Format: 26 multiple-choice items

Population: Students enrolled in grades three and four in Seattle public schools

Reliability: Grade 3 - r = .45 (K-R 20)
Grade 4 - r = .80 (K-R 20)

Validation: Constructed with reference to objectives of TV science program. Items rated by teachers as to appropriateness; 87.6% agreement.

Reference: Beisenherz, Paul Chambers. "An Experimental Study of a Televised Science Series, Grades 1-4, Comparing the Quality and Sequence of Television and Classroom Questions with a Proposed Strategy of Science Instruction." Unpublished doctoral dissertation, University of Washington, 1971, p. 303.
University Microfilms Order No. 72,7319

Title: PICTURE TEST FOR COMPREHENSION OF SCIENCE CONCEPTS (One test for each of three grade levels)

Factors: Achievement in science concepts

Format: Picture and word description of 15 problem situations. Student selects one of three pictures he feels represents a correct result.

Population: Urban kindergarten, first, and second grade children classed as non-readers

Reliability: Not available

Validation: Content validity judged by author and experts

Reference: Boener, Charlotte M. "An Evaluation of the Grade Placement of Science Concepts in the Early Elementary Grades of the Minneapolis Public Schools." Unpublished doctoral dissertation, State University of Iowa, 1965, pp.156-187.
University Microfilms Order No. 66-3411

Title: PICTORIAL-AURAL INVENTORY OF SCIENCE KNOWLEDGE

Factors: Achievement in science knowledge

Format: 60 picture multiple-choice items

Population: Fifth grade students

Reliability: r = .73 (Split-halves method using Spearman-Brown Prophecy Formula)
N = 300

Validation: Four-member jury

Reference: Finkelstein, Leonard B. "The Development of a "Reading Free" Testing Procedure for the Evaluation of Knowledge and Understandings in Elementary School Science." Unpublished doctoral dissertation, Temple University, 196[illegible], p. 127.
University Microfilms Order No. 68-4505

Title: READING INVENTORY OF SCIENCE KNOWLEDGE

Factors: Achievement of science knowledge

Format: 60 multiple-choice items

Population: Fifth grade students

Reliability: r = .86 (Split-halves method using Spearman-Brown Prophecy Formula)
N = 360

Validation: Four-member jury

Reference: Finkelstein, Leonard B. "The Development of a "Reading Free" Testing Procedure for the Evaluation of Knowledge and Understandings in Elementary School Science." Unpublished doctoral dissertation, Temple University, 1967, pp. 122-126.
University Microfilms Order No. 68-4505

Title: [LEVEL OF UNDERSTANDING OF SCIENCE CONCEPTS]

Factors: Achievement in understanding certain concepts at the knowledge, comprehension and application levels

Format: 40 multiple-choice items

Population: Second through sixth grade students

Reliability: Internal consistency reliability determined through use of Hoyt analysis of variance.
Knowledge = .80 Comprehension = .74
Application = .75 Total = .90

Norms: Listed by concept and level in dissertation

Validation: Content validity assessed by jury

Reference: Helgeson, Stanley L. "An Investigation into the Relationships Between Concepts of Force Attained and Maturity as Indicated by Grade Levels." Unpublished doctoral dissertation, University of Wisconsin, 1967, p. 146.
University Microfilms Order No. 67-16956

Title: QUALITY CONCEPT INVENTORY OF TWENTY SELECTED SCIENCE WORDS

Factors: Levels of comprehension of twenty science words

Format: Two forms; primary for grades K-3, intermediate for grades 4-6.
Primary: Respondent identified most important of three statements associated with each word.
Intermediate: Respondent assessed the correctness of each statement and ranked them in order of importance.

Population: Children in grades kindergarten through sixth in Colorado schools

Reliability: Determined in pilot studies, but not reported

Norms: Not available. Given to 6,447 students

Validation: 48-member jury assessed validity of statements and ranked them according to complexity. Reliability coefficient for rankings ranged from .91 to .99 for the 20 sets of statements.

Reference: Kerns, LeRoy Raymond. "A Study of the Differences of Comprehension that Pupils in Colorado Elementary Schools Have of Twenty Selected Science Words." Unpublished doctoral dissertation, University of Colorado, 1963, pp. 233-253.
University Microfilms Order No. 64-1927.

Title: [MCBRIDE SCIENCE ACHIEVEMENT TEST]

Factors: Achievement in science

Format: 40 multiple-choice items

Population: Fifth and sixth grade students

Reliability: Spearman-Brown split-half correlation;
6th grades = .87 5th grades = .85 N = 2934

Norms: $\overline{X}$ = 15.31 to 17.60 S.E. = .13 - .17

Validation: Six-member jury

Reference: McBride, Richard E. "The Effect of an In-Service Science Training Program for Teachers on the Achievement of Elementary School Children." Unpublished doctoral dissertation, Cornell University, 1967, pp. 94-105.
University Microfilms Order No. 67-12623

Title: A TEST OF SCIENCE COMPREHENSION

Factors: Comprehension of science information

Format: Two parts, each consists of 30 multiple-choice items. Items are based on four situations.

Population: Students in upper elementary grades

Reference: Nelson, Clarence H. and John M. Mason. "A Test of Science Comprehension for Upper Elementary Grades." Science Education, Vol. 47, No. 4:319-330, October, 1963.

Title: NON-READING CONCEPT TEST

Factors: Understanding of concepts of light and shadows

Format: 32 drawings with multiple-choice questions related to each drawing. Pictures in reference; filmstrip also available at the New York University Library.

Population: Second grade pupils from the New York City school district

Reliability: $r = .69$ (K-R 20)
$N = 160$

Validation: Content validation by jury. Correlations with reading scores and mental age were not significant.

Reference: Sack, Nathan. "To Develop and Analyze a Non-Reading Group Test on the Concepts of Light and Shadows for Second Grade English Speaking Pupils in New York City School District." Unpublished doctoral dissertation, New York University, 1971, p. 71.
University Microfilms Order No. 72-20,661

Title: [UNDERSTANDING OF SCIENCE CONCEPTS] (3 tests)

Factors: Knowledge, comprehension and application of selected science concepts

Format: 35 to 40 multiple-choice items

Population: Sixth grade pupils

Reliability: Kuder-Richardson internal consistency formula used to establish reliabilities of .64 to .71.
$N = 186 - 190$

Norms: $\bar{X} = 19.82 - 20.27$ S.E. $= 2.57 - 2.83$

Validation: Not available

Reference: Schulz, Richard W. "The Role of Cognitive Organizers in the Facilitation of Concept Learning in Elementary School Science." Unpublished doctoral dissertation, Purdue University, 1966, pp. 143-171.
University Microfilms Order No. 67-5495

Title: SCIENCE CONCEPT TEST (PCE); DETROIT EDITION

Factors: Understanding of selected science concepts

Format: Seven pictorial representatives of a science concept; Each is followed by three multiple-choice items.

Population: Ten and eleven year old children enrolled in Detroit elementary schools

Reliability: Not available

Validation: Two groups of students were identified; those that scored well on certain concepts and those that scored poorly on the same concepts. These students were interviewed by teachers who evaluated their understanding of the same concepts. The hypothesis that no relationship existed between PCE results and teacher assessment of students understanding could be rejected.

Reference: Scott, Norval C., Jr. "The Relationship of Inductive Reasoning and Cognitive Styles in Categorization Behavior to Science Concept Achievement in Elementary School Children." Unpublished doctoral dissertation, Wayne State University, 1962, pp. 171-193.
University Microfilms Order No. 63-2223

Title: [SMITH SCIENCE TEST]

Factors: Achievement of the behavioral objectives of the following units: 1) Seeds, 2) Classification, 3) Temperature, 4) Time, 5) Water, 6) Energy

Format: Oral examination

Population:
1 and 2-----------First Graders
3 and 4-----------Third Graders
5 and 6-----------Sixth Graders

Reliability: Not available

Norms:
1 and 2 N = 160 No Means, etc. given
3 and 4 N = 192
5 and 6 N = 190

Validation: Not established

Reference: Smith, George F. "A Study of the Effects on Student Achievement in Elementary Science Programs Resulting from Teacher In-Service Training and Additional Instructional Aids." Final Report, Project #8-B-020, Office of Education, June, 1969, pp. 145-158.
ED 041 762 MF $0.65 HC $6.58 167 pp.

Title: [STAUSS SCIENCE CONCEPT TESTS]

Factors: Knowledge, comprehension, application of selected science concepts

Format: Eleven tests of 36 "yes-no items" each

Population: Pupils from grades 2-6 of heterogeneous socioeconomic grouping

Reliability: Range from .44 to .85 N = 100

Validation: Not available

Reference: Stauss, Nyles G. "An Investigation into the Relationship Between Concept Attainment and Level of Maturity." Unpublished doctoral dissertation, University of Wisconsin, 1967, pp. 239-279.
University Microfilms Order No. 67-17030

Title: SCIENCE ACHIEVEMENT TEST

Factors: Achievement in content areas of Trees, Soil and Temperature at two cognitive levels: Part I, knowledge; Part II, comprehension.

Format: 60 multiple-choice items

Population: Fifth grade students

Reliability: r = 0.90 Total (K-R 20)
r = 0.84 Part I
r = 0.82 Part II
N = 30

Norms:		Pretest	Posttest
	Part I	$\bar{X} = 9.68$	17.57
	Part II	$\bar{X} = 8.66$	14.24
		$N = 87$	87

Validation: Content validity established by jury

Reference: Wise, Clarence Ronald. "Outdoor Versus Indoor Learning in Elementary School Science." Unpublished doctoral dissertation, The Pennsylvania State University, 1970, p. 122.
University Microfilms Order No. 71-16,686

CHAPTER TWO

ACHIEVEMENT IN THE PROCESSES AND SKILLS OF SCIENCE

The instruments in this chapter are designed to measure students' ability to effectively engage in the processes and skills involved in scientific inquiry. They are grouped by educational level.

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Title: TEACHER PROCESS TEST

Factors: Processes of classification and interpretation

Format: 18 objective response items based on completion of specified tasks; 12 multiple-choice items, 3 open-ended items.

Population: Elementary teachers in Seattle public schools

Reliability: $r = .80$ (K-R 20)
$N = 54$

Validation: Constructed with reference to objectives of TV science program; items rated by teachers as to appropriateness: 74% agreement.

Reference: Beisenherz, Paul Chambers. "An Experimental Study of a Televised Science Series, Grades 1-4, Comparing the Quality and Sequence of Television and Classroom Questions with a Proposed Strategy of Science Instruction." Unpublished doctoral dissertation, University of Washington, 1971, p. 237.
University Microfilms Order No. 72,7319

Title: THE BURMESTER TEST OF ASPECTS OF SCIENTIFIC THINKING

Factors: Understanding of five abilities involved in scientific thinking

Format: Several subtests each consisting of the statement of a problem and a series of multiple-choice items based on that problem.

Population: First year education students

Reliability: $r = .85$ (K-R 20)

Validation: Comparison of test results with judges ratings of students yielded correlations of 0.72 and 0.77. Correlation with test of intelligence, reading ability and factual information ranged from 0.38 to 0.51.

Reference: Burmester, Mary Alice. "The Construction and Validation of a Test to Measure Some Inductive Aspects of Scientific Thinking." Science Education, Vol. 37: 131-140, 1953.

Complete test in: Hall, John Franz. "The Use of History of Science Case Studies With First Year Education Students to Teach Skills Involved in Scientific Thinking." Unpublished doctoral dissertation, Oregon State University, 1972, p. 182.
University Microfilms Order No. 71-27,854

Title:	PROCESS SKILLS OF SCIENCE TEST: INTEGRATED PROCESSES
Factors:	Assess the integrated process skills of science as defined by the Commission on Science Education of the American Association for the Advancement of Science; formulating hypotheses, defining operationally, controlling variables, interpreting data and experimenting.
Format:	48 five-response multiple-choice items
Population:	Advanced undergraduate college students majoring in elementary education
Reliability:	r = .81 (K-R) S.D. = 7.31 N = 428
Norms:	Range = 0 - 46 Standard Error = 0.353
Validation:	Content validity established by jury selected nationwide. Concurrent validity established through use of Watson-Glaser Critical Thinking Appraisal, Processes of Science Test (BSCS) and Science Process Measure for Teachers (AAAS).
Reference:	Burns, Sandra Flynn. "The Development of a Test to Measure Performance of Elementary Education Majors on the American Association for Advancement of Science's Integrated Process Skills of Science." Unpublished doctoral dissertation, The University of Connecticut, 1972, p. 162. University Microfilms Order No. 72-32,205

Title: X - 35 TEST OF PROBLEM SOLVING

Factors: Identification of the following behaviors considered to be part of the practice of science: 1) Early formation of hypothesis; 2) Specific experimentation with relevant variables as contrasted to random guessing; 3) Introduction of control to test the validity of a hypothesis selected; 4) Specific attempts at verification of the hypothesis.

Format: The instrument presents the respondent with 1) a specific problem, 2) data he might employ in solving the problem, 3) a list of possible solutions including the correct one. Responses judged on a scale of 1 to 5 with reference to the four criteria quoted above.

Population: College students

Reliability: Comparison of individual scores in the two problems of the instrument yielded a reliability coefficient of .54.

Validation: Construct validity with reference to a defined model of problem solving behavior. Agreement between evaluations of investigator and judges on the three parts ranged from .62 to .87.

Reference: Butts, David P. "The Evaluation of Problem Solving in Science." Journal of Research in Science Teaching, Vol. 2:116-122, 1964.

Title: [CHEMISTRY LABORATORY SKILLS TESTS] 13 TESTS

Factors: Achievement of laboratory skills in chemistry including; equipment identification, general operations, special operations, errors in technique, interpreting experiments, use of tools, designing experiments for several purposes, measurement of characteristics, ordering data, formulating hypothesis and predicting effects of actions.

Format: The 13 tests each consist of one situation with a variable number of questions requiring essay, short answer or matching responses. Situations are presented through color slides and color motion picture scenes.

Population: College chemistry students

Reliability: Not available

Validation: Not available

Reference: Jeffrey, Jack C. "Identification of Objectives of the Chemistry Laboratory and Development of Means for Measuring Student Achievement of Some of These Objectives." Unpublished doctoral dissertation, The University of Texas, 1965, p.154. (Photographic materials not included.)
University Microfilms Order No. 66-1928

Title: GRAPH INTERPRETATION INSTRUMENT

Factors: Ability to interpret graphs

Format: 15 multiple-choice items based upon graphs

Population: Majors (juniors or seniors) in elementary education

Reliability: Not available

Norms: $\bar{X}$ = 23.23 - 23.25
S.D. = 5.81 - 5.87
N = 53 - 54 (Pretest)

Validation: Critical examination by experts

Reference: Kellogg, Maurice G. "The Effect of Laboratory-Discovery Methods and Demonstration-Discussion Methods Upon Elementary Science Methods Students' Abilities to Analyze and Interpret Graphs." Unpublished doctoral dissertation, University of Indiana, 1966, p. 87.
University Microfilms Order No. 67-4012

Title: OPERATIONS OF SCIENCE TEST

Factors: Ability to make various scientific operations such as analyzing data and drawing inferences

Format: 40 multiple-choice items

Population: Secondary school biology teachers

Reliability: r = .79 (K-R 20)

Norms: $\bar{X}$ (pretest) = 14.40
S.D. = 5.93

Validation: Method not indicated

Reference: Ost, David Harry. "An Analysis of the Effects of a Summer Institute in Biology Upon Teachers' Classroom Behavior and Attitude Towards BSCS Rationale." Unpublished doctoral dissertation, The University of Iowa, 1971, p. 99.
University Microfilms Order No. 71-22,072

Title: THE PROBLEM-SOLVING TEST

Factors: Problem-solving skills such as forming, testing, revising and reporting of hypotheses

Format: Respondent reports all he can about the inside of a closed box, collecting data by any means except opening the box. Final test consists of 21 boxes.

Population: College students

Reliability: r = .84 (Split-half method)
N = 50

Validation: Test scores and time spent on test were compared with scores on standardized instruments which purport to measure aspects of problem-solving ability.

Reference: Perisho, Clarence R. "A Problem-Solving Test - The Construction of a Manipulative Performance Test Designed to induce the Collection and Use of Perceptive Data in the Formulation and Inferential Verification of Hypothesis." Unpublished doctoral dissertation, New York University, 1963, pp. 145-165.
University Microfilms Order No. 63-6674

Title: LABORATORY PERFORMANCE TEST

Factors: Achievement in physics laboratory skills

Format: Six laboratory problems

Population: College students enrolled in introductory physics courses

Reliability: $r = .596$ (K-R 20)
N = 124

Norms: $\bar{X} = 14.08$ (24 points maximum)
N = 124

Validation: Three-member panel

Reference: Smith, John R. "A Comparison of Two Methods of Conducting Introductory College Physics Laboratories." Unpublished doctoral dissertation, University of Northern Colorado, 1969, pp. 76-79.
University Microfilms Order No. 70-7168

Title: BIOLOGY PROBLEM SOLVING TEST

Factors: Achievement in four areas of problem solving behavior; 1) to recognize and comprehend problems, 2) to suggest and screen hypotheses, 3) to interpret data and draw conclusions, 4) to reason quantitatively and symbolically.

Format: Four subtests corresponding to problem solving behaviors each consisting of multiple-choice items (15, 30, 22, and 8 items respectively).

Population: Freshmen students in college biology

Reliability: Not available.
N = 20

Validation: Face validity established by jury

Reference: Sparks, Elbert, Jr. "Problem Solving Techniques of College Biology Students with Implications for Secondary School Teachers." Unpublished doctoral dissertation, University of Alabama, 1970, p. 121.
University Microfilms Order No. 71-1275

Title: PROBLEM SOLVING TEST

Factors: Problem solving ability

Format: Six problems

Population: College students enrolled in an introductory botany course

Reliability: r = .30 and .50 (Jackson method)

Validation: Jury of university staff members in botany and education

Reference: Novak, Joseph D. "A Comparison of Two Methods of Teaching a College General Botany Course." Unpublished doctoral dissertation, University of Minnesota, 1957, p. 163.
University Microfilms Order No. 58-2159

Title: PHYSICS TEST II

Factors: Mathematical and physics problem solving ability

Format: 45 multiple-choice items

Population: College freshmen

Reliability: r = .713 (Split-halves technique using Spearman-Brown formula)
N = 211

Validation: Content validity by jury. Concurrent validity by comparison with standardized test results and teacher grades.

Reference: Sandler, Barney. "A Comparison of an Integrated Course in College Physics and Mathematics of One Semester Duration with Separate Courses in the Two Subjects in a Two Year Community College." Unpublished doctoral dissertation, New York University, 1961, p. 82.
University Microfilms Order No. 62-1429

Title: TEST OF UNDERSTANDING OF THE ELEMENTS OF MODEL BUILDING

Factors: Level of understanding of model building

Format: 48 multiple-choice items

Population: Eighth grade science students

Reliability: $r = .31$ to $.71$ (K-R 20)
$N = 817$

Norms: $\bar{X} = 23.08$ and 19.93
S.D. = 6.85 and 6.25 (Post-test)

Validation: Face validity determined by 7-member jury

Reference: Devito, Alfred. "The Contribution of Certain Science Investigations to the Understanding of the Elements of Scientific Model Building by General Science Students Enrolled in a Three-Track Curriculum." Unpublished doctoral dissertation, University of Texas at Austin, 1966, pp. 191-203.
University Microfilms Order No. 66-14,369

Title: CONCEPT-PROCESS TEST

Factors: Understanding of scientific concepts and processes. Test designed to be used in assessing these factors in classes representing all the commonly taught secondary science curriculums.

Format: 38 multiple-choice items subdivided into concept and process subscales

Population: Science students in grades 6 through 12 in schools of central Ohio

Reliability: Total r 0.835 (K-R 20) N = 1399
Concept r = 0.655
Process r = 0.802

Norms: Total $\bar{X} = 18.22$ S.D. = 3.15 (38 items)
Concept $\bar{X} = 9.69$ S.D. = 3.51 (20 items)
Process $\bar{X} = 8.54$ S.D. = 4.25 (18 items)

Validation: Jury evaluation of items in item pool with reference to the publication *Theory into Action in Science Curriculum Development*. Washington: NSTA, 1964. Item analysis from preliminary testing of items used in selecting those on final form of instrument.

Reference: Disinger, John A. "Student Development, Teacher Characteristics, and Class Characteristics." Unpublished doctoral dissertation, The Ohio State University, 1971, pp. 212-225.
University Microfilms Order No. 72-4470

Title: SEVENTH GRADE MATTER SKILLS TEST

Factors: Science laboratory skills

Format: Practical

Population: Seventh grade students of a university school

Reliability: Not available

Validation: Face validity

Reference: James, Robert K. "A Comparison of Group and Individualized Instructional Techniques in Seventh Grade Science." Unpublished doctoral dissertation, University of Iowa, 1969, pp. 123-129.
University Microfilms Order No. 69-21,698

Title: SPECIAL EARTH SCIENCE EXAMINATION

Factors: Level of inquiry ability

Format: 50 multiple-choice items

Population: Ninth grade earth science students

Reliability: Not available

Validation: Twenty-four member jury held 89% agreement on items using high versus low inquiry ability.

Reference: Ladd, George T. "Determining the Level of Inquiry in Teachers' Questions." Unpublished doctoral dissertation, Indiana University, 1969, pp. 61-72.
University Microfilms Order No. 70-11,698

Title: PERFORMANCE TEST: UNIT I

Factors: Objectives dealing with those processes of science students are expected to achieve in Part I after PSSC physics course.

Format: 12 items most of which are multiple-choice

Population: High school physics students

Reliability: r =.762 (K-R 20)
S.E. = 1.470

Norms: $\overline{X}$ = 10.52
S.D. = 3.58

Validation: Face validity investigated through a comparison of process areas initially identified and those evaluated in the revised instrument. Moderately high correlation with previous achievement in science provided predictive-concurrent validity.

Reference: Penny, Maria Bramtot. "The Development and Validation of a Process Instrument for a Unit of the Physical Science Study Committee Physics Course." Unpublished doctoral dissertation, University of Maryland, 1971, p. 126.
University Microfilms Order No. 72-1675

Title: LABORATORY PRACTICAL

Factors: Ability in; measurement, identification, interpreting and determining interrelationships

Format: 20 laboratory setups, one question related to each setup

Population: High school biology students

Reliability: Hoyt analysis of variance yielded reliability of .63.
N = 390

Norms: $\overline{X}$ = 11.3 S.D. = 3.2

Validation: Not available

Reference: Robinson, James T. "Evaluating Laboratory Work in High School Biology." *American Biology Teacher*, Vol. 31, No. 4:236-240, April, 1969.

Title: PRACTICAL LABORATORY EXAMINATION

Factors: Laboratory skills (manipulative and intellective) utilized in BSCS curricula

Format: Seven problems with instructions to students and questions to be answered

Population: Twelfth-grade Israeli students

Reliability: High degree of evaluator agreement

Norms: $\overline{X} = 74.34$ (Maximum = 100) S.D. = 9.49 N = 99

Validation: Content and construct validity claimed by authors

Reference: Tamir, P. and Glassman, F. "A Practical Examination for BSCS Students." Journal of Research in Science Teaching, Vol. 7:107-112, 1970. Complete instrument available from authors c/o Israeli Science Teaching Centre, Hebrew University, Jerusalem.

Title: THE TEST OF SCIENCE PROCESSES

Factors: The ability to use the following processes:
1) observing 2) comparing 3) classifying
4) quantifying 5) measuring 6) experimenting
7) inferring 8) predicting

Format: 96 multiple-choice items

Population: Junior high school students

Reliability: r = .90 - .91 total (K-R 20)
Subtest = 1) .41 - .47 2) .26 - .37 3) .58 - .71
4) .64 - .75 5) .71 - .82 6) .43 - .54 7) .48 - .63
8) .32 - .56

Norms: Included in dissertation

Validation: Criterion-related validity assessed through correlation of student scores with the teacher ratings of students. Correlations ranged from .115 to .477.

Reference: Tannebaum, Robert S. "The Development of the Test of Science Processes." Unpublished doctoral dissertation, Columbia University, 1968, Appendix.
University Microfilms Order No. 69-677

Title: BASIC SCIENCE PROCESSES TEST

Factors: Achievement in science processes as defined by AAAS

Format: Slides and correlated audio-tapes

Population: First through third graders from agriculturally oriented community

Reliability: r = .353 - .711 (Test-retest)
N = 854

Validation: Not available

Reference: Beard, Jean. "Group Achievement Tests Developed for Two Basic Processes of AAAS (American Association for the Advancement of Science) Science -- A Process Approach." Unpublished doctoral dissertation, Oregon State University, 1970.
Available from: William Jasper Kerr Library, Oregon State University, Corvallis, Oregon 97331.

Title: PICTURE TEST FOR SCIENCE PROCESSES
1. Grades 1 and 2
2. Grades 3 and 4

Factors: Processes of classification and interpretation

Format:
1. 33 item picture test using oral cues and directions.
2. 18 item picture test with printed cues and directions.

Population: Students enrolled in grades 1-4 in Seattle public schools

Reliability: (K-R 20)
Grade 1 - r = .41
Grade 2 - r = .53
Grade 3 - r = .60
Grade 4 - r = .61

Validation: Constructed with reference to objectives of TV science program. Items rated by teacher as to appropriateness; 1) 80.6% agreement, 2) 60.0% agreement.

Reference: Beisenherz, Paul Chambers. "An Experimental Study of a Televised Science Series, Grades 1-4, Comparing the Quality and Sequence of Television and Classroom Questions with a Proposed Strategy of Science Instruction." Unpublished doctoral dissertation, University of Washington, 1971, Appendix.
University Microfilms Order No. 72,7319

Title: COMBINATIONAL PROBLEM TEST

Factors: Combinational skill in mathematics and general science

Format: Ten problems

Population: Sixth grade students in middle class, suburban area

Reliability: r = .8109 (Test-retest method using Pearson r correlation)
N = 32

Validation: Eight-member jury

Reference: Dyril, Odvard E. "An Investigation into the Development of Combinatorial Mechanisms Characteristic of Formal Reasoning, Through Experimental Problem Situations with Sixth-Grade Students." Unpublished doctoral dissertation, Indiana University, 1967, pp. 105-112.
University Microfilms Order No. 68-4717

Title: [FYFFE PROCESS TEST]

Factors: Process skill acquisition in the processes of; formulating hypotheses, and defining operationally, as defined in the AAAS - SAPA materials.

Format: 79 multiple-choice items

Population: Elementary school students

Reliability: Not determined

Validation: Concurrent validity established by correlating test scores with scores on the Individual Competency Measures from SAPA.

Reference: Fyffe, Darrel Wayne. "The Development of Test Items for the Integrated Science Processes: Formulating Hypotheses and Defining Operationally." Unpublished doctoral dissertation, Michigan State University, 1971, p. 80.
University Microfilms Order No. 72-16,427

Title: TAB SCIENCE TEST

Factors: Inquiry behaviors of searching, data processing, verifying, discovering, assimilating and accomodating.

Format: Tab-item

Population: Fourth, fifth and sixth grade students from wide socioeconomic range

Reliability: Coefficients of equivalence = .420 (N = 238) and internal consistency of .497 (form A) and .532 (form B).

Norms:

Form	Max. Score	Mean	S.D.	N
A	364	256	51.5	1264
B	346	260	58.5	1255

Validation: Concurrent validity analysis with teacher rankings (.64)

Reference: Jones, Howard L. "The Development of a Test of Scientific Inquiry, Using the TAB Format, and an Analysis of Its Relationship to Selected Student Behaviors and Abilities." Unpublished doctoral dissertation, The University of Texas at Austin, 1966, pp. 104-132.
University Microfilms Order No. 66-7339

Title: SCIENCE PROCESS SKILLS TEST

Factors: Skills of inference, prediction and verification

Format: Items and item distracters presented in form of illustration; test instructions are oral. 42 items.

Population: Children in grades four, five and six.

Reliability: (K-R 20)
r = .837 Total
r = .778 Inference Scale
r = .778 Verification Scale
r = .668 Prediction Scale

Norms: $\bar{X} = 15.46$
$N = 50$

Validation: Content validation by three-member panel

Reference: Molitor, Loretta Louise. "An Investigation to Develop an Instrument to Evaluate the Science Skills of Inference Prediction and Verification of Children in Grades Four, Five and Six." Unpublished doctoral dissertation, University of Pennsylvania, 1971, p. 159.
University Microfilms Order No. 72-14,644

Title: TAB SCIENCE PUZZLER (3 FORMS)

Factors: Aspects of problem-solving performance; 1) Problem Orientation, 2) Problem Identification, 3) Problem Solution, 4) Data Analysis, 5) Problem Verification.

Format: Respondents answer a series of questions based upon the viewing of a film

Population: Fourth, fifth, and sixth grade children from the Austin (Texas) Independent School System.

Reliability: Interform reliabilities range from .42 to .80

Validation: Science knowledge test also developed to assess previous knowledge of science principles involved in each form of TAB Science Puzzler. Concurrent validity assessed through correlation with scores on the *Inference Test* from the *Kit of Reference Tests for Cognitive Factors*.

Reference: Norton, Robert Eugene. "A Developmental Study in Assessing Children's Ability to Solve Problems in Science." Unpublished doctoral dissertation, The University of Texas, 1971, p. 77.
University Microfilms Order No. 72-19,638

Title: FIFTH GRADE SCIENCE PROBLEM SOLVING TEST

Factors: Ability to: 1) identify hypotheses
2) identify problems
3) identify valid conclusions

Format: 36 multiple-choice items based on description of hypothetical situations

Population: Fifth grade students

Reliability: r = .81 (Test-retest method using Pearson's Product-Moment Correlation)
N = 811

Norms: $\overline{X}$ = 4.89 to 6.49
N = 27 (each of three groups)

Validity: Content validity purported by author, based on objectives of science education as developed by Commission on Science Education of the American Association for the Advancement of Science.

Reference: O'Toole, Raymond J. "A Study to Determine Whether Fifth Grade Children Can Learn Certain Selected Problem Solving Abilities Through Individualized Instruction." Unpublished doctoral dissertation, University of Northern Colorado, 1966, pp. 76-88.
University Microfilms Order No. 67-60800

Title: TEST OF SCIENCE INQUIRY SKILLS

Factors: Process skills of identifying and controlling variables, interpreting data, predicting and inferring as included in grades 3, 4, and 5 of the program developed by Science Curriculum Improvement Study.

Format: 50 objective-type items

Population: Fifth grade students

Reliability: r = .9033 (K-R 20)
N = 310

Validation: Panel of science educators and correlation with the Science Test (Form A) of the Sequential Test of Educational Progress (Series III) provided validity.

Reference: Riley, Joseph William. "The Development and Use of a Group Process Test for Selected Processes of the Science Curriculum Improvement Study." Unpublished doctoral dissertation, Michigan State University, 1972, Appendix.
University Microfilms Order No. 73-12,807

Title: COMPETENCY MEASURES FOR GROUPS

Factors: Assess the 24 specific behaviors listed as behavioral expectancies for exercises A-K of Part A of Science -- A Process Approach.

Format: 56 tasks administered in a group testing situation

Population: Kindergarten students

Reliability: $r = .78$ (K-R 21)
$N = 44$

Norms: $\overline{X} = 33.97$ S.D. = 6.24 (Post-test) $N = 60$

Validation: Content validity by author

Reference: William C. Ritz
Staff Associate
Eastern Regional Institute for Education
635 James Street
Syracuse, New York 13203

Title: ERIE SCIENCE PROCESSES TEST

Factors: Skills reflecting the process orientation of *Science - A Process Approach* curriculum

Format: 35 multiple-choice items

Population: Students in fourth and fifth grades

Reliability: $r = .72$ (K-R 20)
$N = 846$

Validation: Content validity for experimental version of the curriculum

Reference: See Appendix p. 213.

Title: SOME QUESTIONS ABOUT SCIENCE

Factors: Understanding of science processes

Format: Eleven objective items

Population: Students from grades 3 through 6

Reliability: $r = .50$ (Hoyt)
$N = 529$

Validation: Developed with reference to Table of Specification outlining the major processes used in the SAPA program.

Reference: Wideén, Marvin Frank. "A Product Evaluation of *Science - A Process Approach*." Unpublished doctoral dissertation, University of Colorado, 1971, p. 88.
University Microfilms Order No. 72-3721

CHAPTER THREE

CHARACTERISTICS AND ABILITIES OF STUDENTS

Instruments in this chapter are designed to assess student background characteristics thought either to affect learning in science, or to be improved through instruction in science. They are grouped into several sections; background experiences and attitudes, cognitive preference or structure, creativity, critical thinking, curiosity, and reading and verbal ability. The educational level of the targeted respondent-group is indicated by a code letter (see Chapter One, page 5).

Instrument Title	Level	Page
Background Experiences and Attitudes		
High School Seniors' Response Scale	S	98
Experience Inventory	E	98
Home Attitude Instrument	J	99
Science Experience Inventory	E	99
What Things Do You Like To Do In School?	E	100
Cognitive Preference or Structure		
Cognitive Preference Examination: High School Chemistry	S	100
Cognitive Preference Examination - II	C	101
Cognitive Preference Test: High School Chemistry	S	102
Cognitive Styles Task (CST)	E	102
[Cognitive Structure Test]	S	103
Creativity		
Robinson Test of Scientific Creativity	S	103
Critical Thinking		
Critical Thinking Battery	J	104
A Test of Science Comprehension	E	105
A Test of Critical Thinking Ability in Physical Science, Form 2	S	106
Physical Science Critical Thinking Appraisal	C	106

Instrument Title	Level	Page
Curiosity		
Scientific Curiosity Inventory	J	107
Scientific Curiosity and Interest Inventory	E	107
Curiosity Inventory	S	108
Reading and Verbal Ability		
Reading Comprehension Test: Motion Before Galileo (English and Spanish Versions)	C	108
Multiple-Meaning Word Test	E	109
Cloze Test	C	109
A Science Reading Test (Two Forms)	E	110
Others		
Rods, Springs, Levers	E	111
Scientific Aptitude Survey	J	111
Extremity-Confidence Hypothesis Test	S	112
Science Generalization Test	S	112

Title: HIGH SCHOOL SENIORS' RESPONSE SCALE

Factors: Student's I) confidence in his own abilities as a mathematician, IIA) interest in making mechanical repairs, IIB) interest in certain uses of leisure time, III) sentiments toward science as a humanitarian institution.

Format: Likert-type items; three subscales identified through factor analysis.

Population: High school students

Reliability: Test-retest (Pearson product-moment correlation)

Scale I $r = .93$
Scale II $r = .82$
Scale III $r = .61$

Validation: Construct validity established through factor analysis of pilot test consisting of an original pool of 92 items.

Reference: Pharris, Jimmie Lee. "Some Comparisons of Certain Characteristics of Students Who Elected High School Physics and Those of Students Who Did Not." Unpublished doctoral dissertation, The University of Connecticut, 1971, p. 140.
University Microfilms Order No. 72-14,250

Title: EXPERIENCE INVENTORY

Factors: Past experiences of student relevant to understanding of concepts on air pressure

Format: 20 yes-no items

Population: Third and fifth graders

Reference: Ryder, Exyie Mae Chambliss. "The Effects of Experience Background and an Advance Organizer on Elementary Pupils' Understanding of Selected Science Concepts." Unpublished doctoral dissertation, The University of Michigan, 1970, p. 99.
University Microfilms Order No. 71-23,964

Title: HOME ATTITUDE INSTRUMENT

Factors: Influence of home upon attitudes of students toward science and scientists

Format: 38 items using a five point response scale "Always" to "Never"; and 3 yes-no items.

Population: 9th grade students

Validation: Not determined

Reference: Starring, Ellsworth Arden. "Effects of an Experimental Course for Ninth Grade Science-Shy on Their Attitudes Toward Science and Scientists." Unpublished doctoral dissertation, The University of Michigan, 1972, p. 173.
University Microfilms Order No. 73-11,267

Title: SCIENCE EXPERIENCE INVENTORY

Factors: Determines which of certain experiences are a part of a child's background

Format: Contains 150 statements such as "See a dust storm." "Yes" answer indicates that student has had the experience.

Population: Fourth, fifth and sixth grade students in the Minneapolis public schools; teachers from Minneapolis and Iowa; students at State University of Iowa.

Reliability: All use K-R 20

r = .94	4th grade	N = 435
r = .93	5th grade	N = 521
r = .75	Minnesota teachers	N = 37
r = .83	Iowa teachers	N = 38

Norms: (Positive responses)

4th grade	$\bar{X}$ = 63.51	S.D. = 22.04
5th grade	$\bar{X}$ = 71.98	S.D. = 22.17
Minnesota teachers	$\bar{X}$ = 117.97	S.D. = 15.37
Iowa teachers	$\bar{X}$ = 105.24	S.D. = 18.27

Validation: Formal validity assumed as test items agree with criteria set up in advance for choosing experiences.

Reference: Uhlhorn, Kenneth. "The Preparation, Use, and Application of a Science Experience Inventory." Unpublished doctoral dissertation, State University of Iowa, 1963, pp. 256-257.
University Microfilms Order No. 63-8043

See also: Wahla, James C. "The Relationship Between Sixth-Grade Science Background Experiences and Science Achievement in Selected Urban Elementary Schools." Unpublished doctoral dissertation, University of Michigan, 1967, pp. 73-80.

Title: WHAT THINGS DO YOU LIKE TO DO IN SCHOOL?

Factors: Assess interests of students for various types of school activities

Format: 20 forced-choice items

Population: Students in grades 3 through 6

Reliability: r = .71 (Hoyt)
N = 528

Norms: $\overline{X}$ = 27.81

Validation: Jury

Reference: Wideen, Marvin Frank. "A Product Evaluation of Science - A Process Approach." Unpublished doctoral dissertation, University of Colorado, 1971, p. 84
University Microfilms Order No. 72-3721

Title: COGNITIVE PREFERENCE EXAMINATION: HIGH SCHOOL CHEMISTRY

Factors: Identifying the following types of cognitive preferences as related to chemical information; 1) memory of facts, 2) practical application, 3) critical questioning of information, and 4) fundamental principles.

Format: 35 items each with four possible correct responses. Responses differ in cognitive type. Respondent chooses the one he prefers.

Population: Eleventh grade chemistry pupils from an urban area

Reliability: $r = .41$ to $.78$ (Subscales using test-retest method and the Pearson product-moment formula)
$N = 44$

Norms: 1) $\overline{X} = 6.75$ S.D. = 3.63 2) $\overline{X} = 8.33$ S.D. = 3.13
3) $\overline{X} = 8.65$ S.D. = 4.17 4) $\overline{X} = 10.20$ S.D. = 3.54

Validation: Face validity established by three-member jury

Reference: Atwood, Ronald K. "A Comparative Study of Achievement in CHEM Study Chemistry Among Groups of Eleventh Grade Students Classified on the Basis of Frequency of Choices on a Cognitive Preference Examination." Unpublished doctoral dissertation, Florida State University, 1966, pp. 62-72.
University Microfilms Order No. 67-321

Title: COGNITIVE PREFERENCE EXAMINATION - II

Factors: Cognitive preference; memory, application, questioning

Format: 30 multiple-choice items each having three correct distractors reflecting the three types of cognitive style. Respondent chooses the one he prefers.

Population: Juniors and seniors enrolled in an elementary science and social studies methods course at the University of Kentucky.

Reliability: Test-retest stability coefficients using Pearson product-moment:
application $r = .77$
memory $r = .70$
questioning $r = .74$
$N = 100$

Validation: Critiques by panel of judges

Reference: See Appendix p. 231.

Title: COGNITIVE PREFERENCE TEST: HIGH SCHOOL CHEMISTRY

Factors: Comparison of four types of "cognitive preferences."
1) memory or recall 2) practical application
3) critical questioning 4) identification of a fundamental principle

Format: 100 four-option items, each of the four options reflecting a cognitive type. Respondent chooses the one he prefers.

Population: High school chemistry students

Reliability: Coefficients of reliability (Method not given)
1) 0.70 2) 0.50 3) 0.66 4) 0.28
N = 433 (CBA students)

Norms: Means (Maximum 25) 1) 7.61 2) 7.03 3) 4.53
4) 7.09

Validation: Content validity established by jury of chemists

Reference: See Appendix p. 219.

Title: COGNITIVE STYLES TASK (CST)

Factors: Extent of respondents' cognitive style in categorization behavior

Format: Respondents group photographs of objects and record their reasons. Each response is placed into one of six categories (See page 64 of dissertation for scoring techniques).

Population: Ten and eleven year old children enrolled in Detroit elementary schools

Reliability: Not available

Validation: Based on an Individual Styles Task instrument developed by Sigel

Reference: Scott, Norval C., Jr. "The Relationship of Inductive Reasoning and Cognitive Styles in Categorization Behavior to Science Concept Achievement in Elementary School Children." Unpublished doctoral dissertation, Wayne State University, 1962, p. 201.
University Microfilms Order No. 63-2223

Title: [COGNITIVE STRUCTURE TEST]

Factors: Cognitive structure with reference to physics concepts

Format: Word association test consisting of 14 stimulus words. Number of responses to concept and the overlap between concepts is converted to a relatedness coefficient which is then used to determine relationships between pairs of concepts retrieved from long-term memory.

Population: Male high school students from the Stanford University area; none of whom have taken physics.

Reliability: Not available

Validation: Not available

Reference: Shavelson, Richard Joseph. "Some Aspects of the Relationship Between Content Structure and Cognitive Structure in Physics Instruction." Unpublished doctoral dissertation, Stanford University, 1971, p. 157.
University Microfilms Order No. 71-19,759

Title: ROBINSON TEST OF SCIENTIFIC CREATIVITY

Factors: Scientific creativity; emphasis on divergent scientific thought

Format: Seven parts; Different Uses of Objects, Anagrams, Problem Identification and Solution, Unstructured Stimulus, Amusing Incident, Problem Identification and Solution (2), Structural Ingenuity. Short essay responses scored according to a set of criteria developed by author.

Population: Secondary school students

Reliability: Inter-scorer agreement on tests ranged from 84 to 100 percent

Norms: $\bar{X}$ (experimental group) = 81.84 N = 311
$\bar{X}$ (comparison group) = 68.81 N = 314

Validation: Test results correlated highly with performance of students in science fair. Science fair participants performed better on test than did non-participants.

Reference: Kobe, Katherine E. "Relationship Between Performance on a Scientific Creativity Test and Participation in a Science Fair." Unpublished doctoral dissertation, United States International University, 1968. After p. 95 (includes scoring manual).
University Microfilms Order No. 68-14,757
Developed by: Dr. Willis Robinson, California Western University (mimeographed)

Title: CRITICAL THINKING BATTERY

Factors: Selected abilities involved in critical thinking in the subject matter areas of history, English, science, and mathematics. Each is a teachable skill.

Format. Four parts of 60 items each corresponding to content areas; each part consisting of three subtests corresponding to critical thinking skills within the content area. A variety of multiple-choice type items are used.

Population: Seventh and eighth grade students of Danbury, Connecticut; a city representing a cross-section of family incomes and occupations.

Reliability:

Part	(K-R 20)
I	r = .936
II	r = .908
III	r = .904
IV	r = .944
N	= 1200

Norms:

Part	Possible Score	Mean	S.D.	Number of Cases
I History	60	30.43	13.37	306
II English	60	32.68	11.17	307
III Science	60	34.17	11.37	310
IV Mathematics	60	33.04	13.98	310

Validation: Jury opinion of face validity and correlation with scores on Lorge-Thorndike Intelligence Test, and Iowa Tests of Basic Skills to establish concurrent validity.

Reference: Cillizza, Joseph Edward. "The Construction and Evaluation of a Test of Critical Thinking Ability." Unpublished doctoral dissertation, Boston University, 1970, p. 230.
University Microfilms Order No. 70-22,522

Title: A TEST OF SCIENCE COMPREHENSION

Factors: Critical thinking

Format: Two parts, each containing 30 multiple-choice items based on four situations arranged approximately in order of difficulty. Respondent must analyze the situation to arrive at answers.

Population: Students in grades 4 through 6 in urban and suburban school systems of Michigan

Reliability: Method - G. J. Froelich (in Garrett)

4th grade $r = .72$ $N = 182$
5th grade $r = .79$ $N = 256$
6th grade $r = .76$ $N = 213$
(Based on post-test of the experimental groups)

Norms:
4th grade $\bar{X} = 21.68$ Variance = 47 $N = 182$
5th grade $\bar{X} = 31.08$ Variance = 64 $N = 256$
6th grade $\bar{X} = 33.05$ Variance = 58 $N = 213$
(Based on post-tests of experimental groups)

Validation: Not available

Reference: Nelson, Clarence H. and Mason, John M. "A Test of Science Comprehension for Upper Elementary Grades." Science Education, Vol. 47, No. 4:319-330, October, 1963.

Title: A TEST OF CRITICAL THINKING ABILITY IN PHYSICAL SCIENCE, FORM 2

Factors: Critical thinking abilities and problem solving in physical science

Format: 48 multiple-choice items

Population: Physics students in senior high schools of southwestern Michigan

Reliability: Correlation coefficient (stability) between pre and post test = .77
Pretest reliability = .80 (K-R 21)
N = 1057

Validation: Items submitted to qualified persons in science and science education.

Reference: Poel, Robert Herman. "Critical Thinking as Related to PSSC and Non-PSSC Physics Programs." Unpublished doctoral dissertation, Western Michigan University, 1970, p. 198.
University Microfilms Order No. 71-3944

Title: PHYSICAL SCIENCE CRITICAL THINKING APPRAISAL

Factors: The ability to think clearly in physical science

Format: 71 multiple-choice items

Population: College sophomores enrolled in physical science

Reliability: r = .71 (Split-half technique using Spearman-Brown correlation)

Norms: $\overline{X} = 22.60$ S.E. = 3.12 N = 362

Validation: Author selected and developed items with reference to course content. Two course instructors reviewed items for content validity, accuracy and clarity.

Reference: Zingaro, Joseph S. "An Experimental Comparison Between Two Methods of Teaching College Sophomores the Interrelationship of Physiocochemical Principles in Physical Science." Unpublished doctoral dissertation, Syracuse University, 1965, pp. 50.
University Microfilms Order No. 66-9873

Title: SCIENTIFIC CURIOSITY INVENTORY

Factors: Scientific curiosity

Format: Seven sets of statements; within each set respondent is asked to answer yes or no to each statement in context of two questions which are posed at the beginning of the set.

Population: Junior high school science students

Reliability: r = .896 (Spearman-Brown correlation of split-halves)
N = 251

Validation: Jury

Reference: See Appendix p. 238.

Title: SCIENTIFIC CURIOSITY AND INTEREST INVENTORY

Factors: Scientific curiosity and interests in science

Format: 110 multiple-choice and Likert-type items

Population: Children in grades six through nine from Columbus, Ohio and Portland, Oregon schools

Reliability: (Test-retest)
Curiosity scale r = .44
Self-Perception of curiosity scale r = .68
Like scale r = .69
Have scale r = .73
Total instrument r = .72
N = 175

Validation: High correlation between interest expressed by respondent during an interview and his score on equivalent items on the instrument.

Reference: Richardson, Raymond Paul. "Development and Use of the SCI Inventory to Measure Upper Elementary School Children's Scientific Curiosity and Interests." Unpublished doctoral dissertation, The Ohio State University, 1971, p. 149.
University Microfilms Order No. 72-4622

Title: CURIOSITY INVENTORY

Factors: Curiosity behaviors

Format: 17 items using several different objective response types

Population: High school biology students

Reliability: r = .74 (Test-retest)
N = 46

Validation: Judges

Reference: Stothart, Jimmy Robertson. "Teacher Characteristics, Student Curiosity, and Problem Selection in High School Biology." Unpublished doctoral dissertation, University of Houston, 1972, p. 46.
University Microfilms Order No. 73-7991

Title: READING COMPREHENSION TEST: MOTION BEFORE GALILEO (English and Spanish Versions)

Factors: Reading comprehension in physics

Format: 20 multiple-choice items

Population: Latin American students studying at The University of Texas

Reliability: r = .76 (K-R 20)

Validation: Tests developed in English and content validity established by judges, then translated into Spanish.

Reference: Cooper, Clarence Henry. "An Analysis of Instruction in Spanish and in English Using Materials Developed for Teaching Physics to Latin American College Students." Unpublished doctoral dissertation, The University of Texas at Austin, 1971, p. 292.
University Microfilms Order No. 72-15,733

Title: MULTIPLE-MEANING WORD TEST

Factors: Identification of those meanings of a group of multiple-meaning science words that are known by the respondents

Format: Two parts each containing 80 multiple-choice items

Population: Children in grades four, five and six of the Kingston, New York, public schools

Reliability: Split-halves correlation; r = .88 (Pearson product-moment correlation corrected by the Spearman-Brown Prophecy Formula)

Norms:
Girls $\bar{X}$ = 107.59 S.D. = 21.52 N = 256
Boys $\bar{X}$ = 104.86 S.D. = 27.32 N = 270
Maximum score = 160

Validation: Established through opinions of 23 reading specialists. Item analysis by grade level indicated balanced distribution of items by difficulty.

Reference: Howards, Melvin. "Measuring Children's Understanding of Selected Multiple-Meaning Words as it Relates to Scientific Word Lists." Unpublished doctoral dissertation, New York University, 1962, p. 85.
University Microfilms Order No. 63-6605

Title: CLOZE TEST

Factors: Ability to comprehend, through contextual clues, the operational meaning of verbal directions specific to certain science process tasks.

Format: Cloze format where every fifth word of a paragraph is deleted. Respondent is directed to insert correct word.

Population: Prospective elementary school teachers at Florida State University

Reliability: r = .838 (K-R 20)
N = 42

Norms: $\bar{X} = 214.31$
S.D. = 15.42

Validation: Not available

Reference: Neie, Van ElRoy. "An Investigation of the Relationship Between a Verbal Measure of Predictive Ability and Performance on Selected Science Process Tasks by Prospective Elementary School Teachers." Unpublished doctoral dissertation, The Florida State University, 1970, p. 40.

Title: A SCIENCE READING TEST (two forms)

Factors: Achievement of selected reading skills

Format: Multiple-choice items, some based on reading paragraphs

Population: Third, fourth, fifth and sixth grade students in Edmond, Oklahoma

Reliability: Subsequent administration of equivalent forms yielded correlations on general score of .90 for third graders to .92 for sixth graders.
N = 531 total

Norms: See page 69 of dissertation

Validation: Partially accounted for through techniques used in selection of words and construction of test

Reference: Heath, Phillip Alan. "The Effect of Contemporary Elementary Science Programs of Selected Aspects of Science Reading Achievement." Unpublished doctoral dissertation, Oklahoma State University, 1970, p. 105.
University Microfilms Order No. 71-11,163

Title: RODS, SPRINGS, LEVERS

Factors: Separation of variables

Format: Practical examination with 9 Piaget-type tasks in each of the three subtests

Population: Fifth and sixth grade students

Reliability: r = .79 to .88 (Subtests, using K-R 20)
N = 27

Validation: Not available

Reference: Bredderman, Theodore A. "The Relative Effectiveness of Reinforcement and Conflict Instruction in Developing the Ability to Separate Variables in Fifth and Sixth Grade Children." Unpublished doctoral dissertation, Cornell University, 1967, pp. 97-113.
University Microfilms Order No. 68-3499

Title: SCIENTIFIC APTITUDE SURVEY

Factors: Fourteen competencies thought important in defining scientific talent

Format: 150 multiple-choice items

Population: Eighth grade students of urban California schools

Reliability: r = .93 (K-R 20)
N = 240

Norms: $\overline{X}$ = 74.5 (Max. = 150) S.D. = 16.4

Validation: Correlation with final marks in science classes ranged from .68 (N = 69) to .79 (N = 29). Correlation with teacher assessment was .82 (N = 148)

Reference: Cosgrove, John C. "The Identification of Scientific Talent." Unpublished doctoral dissertation, The University of Southern California, 1962, p. 155.
University Microfilms Order No. 63-2144

Title: EXTREMITY-CONFIDENCE OF HYPOTHESIS TEST

Factors: Risk-taking in explaining biological events

Format: After viewing scenes of a film respondent is to indicate his degree of confidence in a series of hypotheses concerning the events viewed. A five point scale is used "Positive-Impossible."

Population: High school biology students

Reliability: r = .60 (Split-halves)
N = 280

Norms: Part 1 $\overline{X}$ = 12.21 S.D. = 2.85
Part 2 $\overline{X}$ = 12.94 S.D. = 3.37

Validation: Submitted to teachers of students involved. They agreed with degree of risk-taking responses assigned by the author.

Reference: Horn, Jerry George. "Student Risk-Taking in Explanation of Biological Events." Unpublished doctoral dissertation, University of Colorado, 1970, p. 128.
University Microfilms Order No. 71-5896

Title: SCIENCE GENERALIZATION TEST

Factors: Ability to generalize science concepts

Format: 18 true-false items

Population: In this study the instrument was used with high school seniors in eastern Pennsylvania.

Reliability: Not available

Norms: $\overline{X}$ = 17.1777 S.D. = 5.5109 N = 467

Validation: From Sarah P. McCaliy, "The Construction of an Instrument to Measure the Ability to Generalize." Unpublished masters study, University of Pennsylvania, 1950.

Reference: Pantuso, Raymond Joseph. "The Ability of High School Seniors to Understand and Generalize Science Concepts." Unpublished doctoral dissertation, Lehigh University, 1970, p. 122.
University Microfilms Order No. 71-10,526

CHAPTER FOUR

STUDENT ATTITUDES, INTERESTS AND PREFERENCES

This chapter includes instruments designed to assess student interest in science and various forms of science instruction; attitudes toward science as an enterprise and toward scientists; attitudes toward types of classroom instruction and curricula, attitudes toward conservation and the environment, sex, drug abuse, and radioactivity. A letter code indicates the educational level of the intended respondent-group (see page 5).

Section 1: Science and/or Scientists

Attitudes Toward Science Generally

Instrument Title	Level	Page
The California Elementary School Science Attitude Test	E	115
The Beliefs About and Attitudes Toward Science and Scientists Scale	S	115
Attitudes Toward Science and Scientists	C	116
Attitude Inventory	E	117
American River College Science Attitude Inventory	C	117
[Hartman Science Attitude Scale]	S	118
Projective Test of Attitudes	E	118
Scientific Attitude Inventory	S	119
Statements About Science and Scientists	E-J	119
Study of Attitudes Toward Scientists and Science	C	120
Scientific Attitude Test	C	120
[Ralph Science Attitude Scale]	E	121
Schwirian Science Support Scale	E	121
Inventory of Science Attitudes, Interest and Appreciations	E	122
Attitude Scale	J-S	122

Attitudes Toward a Particular Science Discipline

Instrument Title	Level	Page
Biology Attitude Assessment Scale	S	123
[Attitudes Toward Genetics]	C	123
Chemistry Preference Evaluation Instrument	S-C	124
[Astronomy Attitude Scale]	C	124
Attitude Toward Biology	C	125
Biological Science Attitude Scale	C	125

Instrument Title	Level	Page
Interest in Science		
Clarke Science Interest Checklist	E	126
Interest Inventory	C	126
Student Reaction Inventory	C	127
Measurement of Behaviorally Defined Interests: Science	S	128
Science Activities Checklist	J	128

Title: THE CALIFORNIA ELEMENTARY SCHOOL SCIENCE ATTITUDE TEST

Factors: Attitudes toward science

Format: 20 Likert-type items

Population: Fifth and eighth grade students

Reliability: r = .73 (Spearman-Brown)
N = 2901

Validation: Correlation of .47 with science information test

Reference: Brown, Stanley B. "Science Information and Attitudes Possessed by California Elementary Pupils." Unpublished doctoral dissertation, Stanford University, 1951, p. 140.

Available in: Bickel, Robert F. "A Study of the Effect of Television Instruction on the Achievement and Attitudes of Children." Unpublished doctoral dissertation, Syracuse University, 1964, pp. 143-144.
University Microfilms Order No. 65-3447

Title: THE BELIEFS ABOUT AND ATTITUDES TOWARD SCIENCE AND SCIENTISTS SCALE

Factors: Beliefs about science and scientists and attitudes towards those beliefs

Format: Two parts; I - Beliefs and II - Evaluative, each consisting of about 32 multiple-choice items.
Part I scored by awarding one point for each correct answer.
Part II scoring used a complex system relating responses on Part I to responses on Part II.

Population: Developed at an eighth grade reading level. Population consisted of 9-12 graders in three different settings, urban, suburban, and rural.

Reliability: Part I r = 0.79 (K-R 20)
Part II r = 0.86 (Test-retest; Pearson product moment correlation)
Attitude test (combination of Part I and Part II)
r = 0.57 (Test-retest; Pearson product moment correlation)

Norms: See dissertation

Validation: Item pool submitted to panel of seven judges for classification into belief or evaluative items. Responses were subjected to a two-way analysis of variance and yielded an intraplays (judge) correlation of 0.87. Additional assessments of content validity were made.

Reference: Champlin, Robert F. "The Development and Field Testing of an Instrument to Assess Student Beliefs About and Attitudes Toward Science and Scientists." Unpublished doctoral dissertation, The Ohio State University, 1970, pp. 125-139.
University Microfilms Order No. 71-7417

Title: ATTITUDES TOWARD SCIENCE AND SCIENTISTS

Factors: Attitudes toward science and scientists

Format: 67 Likert-type items

Population: Students enrolled in elementary science methods courses

Reliability: r = .9150 (K-R 20)

Validation: Content validity established through jury techniques. Predicted difference between two groups measured by use of instrument thus establishing construct validity.

Reference: Cummings, John Rosswell. "Development of an Instrument to Measure Attitudes Toward Science and the Scientist." Unpublished doctoral dissertation, The Ohio State University, 1970, p. 135.
University Microfilms Order No. 69-22,114

Title:	ATTITUDE INVENTORY
Factors:	Attitude toward relevance of science
Format:	20 items using a five-point Likert-type response scale
polation:	Fourth graders in Nassau County, New York
Reliability:	r = .93 (K-R 20) N = 100
Validation:	Judges
Reference:	Feerst, Frances. "A Comparison of Two Methods of Enriching a Science Curriculum so as to Change the Attitudes of Children Towards the Relevance of Science." Unpublished doctoral dissertation, New York University, 1972, p. 89. University Microfilms Order No. 73-19,422

Title:	AMERICAN RIVER COLLEGE SCIENCE ATTITUDE INVENTORY
Factors:	Attitude toward various aspects of science
Format:	55 Likert-type items
Population:	Students enrolled in junior college level science courses
Reliability:	r = .71 (Test-retest) N = 180
Norms:	See page 34 of dissertation
Validation:	Not available
Reference:	Fellers, William Oscar. "The Change in Attitudes Toward Science Upon Completion of a One Semester General Education Physical Science Course at the Junior College Level." Unpublished doctoral dissertation, University of Northern Colorado, 1972, p. 102. University Microfilms Order No. 72-23,800

Title: [HARTMAN SCIENCE ATTITUDE SCALE]

Factors: Attitudes toward science and scientists

Format: Semantic differential form with 15 statements about science, each to be rated on five evaluation scales and five belief scales.

Population: High school students

Reliability: r = .78 (Hoyt)
r = .83 (Test-retest)
N = 505

Validation: Instrument developed according to the Fishbein model of attitude. Criterion and construct validity assessed through analysis of results obtained from the evaluative scale only and the Allison Attitude Instrument.

Reference: Hartman, Dean DeVere. "The Determination of the Applicability of the Fishbein Model of Attitudes in Ascertaining the Attitudes Toward Science Held by High School Students." Unpublished doctoral dissertation, The University of Wisconsin, 1972, p. 108.
University Microfilms Order No. 72-29,489

Title: PROJECTIVE TEST OF ATTITUDES

Factors: Attitudes toward science, scientific processes and scientists

Format: Word association items, sentence completion items and an apperception test

Population: Fifth grade students

Reliability: Not available

Validation: Interface validity determined between like sections of the instrument

Reference: Lowery, Lawrence F. "An Experimental Investigation into the Attitudes of Fifth Grade Students Toward Science." Unpublished doctoral dissertation, University of California, 1965, pp. 406-429.
University Microfilms Order No. 65-13424

Title: SCIENTIFIC ATTITUDE INVENTORY

Factors: Attitudes toward science (intellectual)
Attitudes about science (emotional)

Format: 60 Likert-type items

Population: Low-ability tenth-grade biology students

Reliability: r = .934 (Test-retest method of Winer)
N = 23

Norms: See article

Validation: Jury

Reference: Moore, Richard W. and Frances X. Sutman. "The Development, Field Test and Validation of an Inventory of Scientific Attitudes." Journal of Research in Science Teaching, Vol. 7:85-94, 1970.

Title: STATEMENTS ABOUT SCIENCE AND SCIENTISTS

Factors: Attitudes toward science (Part I) and scientists (Part II)

Format: Consists of 68 statements with "Agree," "Undecided," and "Disagree" as possible responses.

Population: Sixth and ninth grade students from rural, urban and suburban communities

Reliability:

Part I	Part II	Total
.48	.78	.79

N = 981 (6th grade students)

Norms: See page 42 of dissertation

Validation: Validated by jury of scientists and science educators

Reference: Motz, LeMoine Lee. "The Development of an Instrument to Evaluate Sixth and Ninth Grade Students Attitudes Toward Science and Scientists." Unpublished doctoral dissertation, The University of Michigan, 1970, p. 118.
University Microfilms Order No. 71-23,833

Title: STUDY OF ATTITUDES TOWARD SCIENTISTS AND SCIENCE

Factors: Attitude toward scientists and science

Format: Two forms consisting of items answerable on a 9 point scale from "Highest Appreciation" to "Highest Depreciation" (32 items and 44 items)

Population: Students enrolled in introductory college chemistry course

Reliability: 1) Test divided into two parts each of which had the same mean score. Split-half technique using Spearman-Brown formula yielded an r = .63 (N = 212)
2) Test-retest method yielded an r = .60 (N = 119)

Norms: See dissertation
N = 467

Validation: Opinions forming the statements to be included in the instrument were rated by three groups of judges on the one to nine scale.

Reference: Myers, Byron E. "An Appraisal of Change of Attitudes Toward Science and Scientists and of Student Achievement in an Introductory College Chemistry Course Relative to the Students' Backgrounds in High School Chemistry and Physics." Unpublished doctoral dissertation, The Pennsylvania State University, 1967, p. 284.
University Microfilms Order No. 68-8727

Title: SCIENTIFIC ATTITUDE TEST

Factors: Attitudes toward science

Format: Student indicates feelings toward 35 ideas or activities (unpleasant, pleasant, none)

Population: College students enrolled in Introductory Botany

Reliability: r = .53 (Hoyt method)

Norms: See dissertation

Validation: Jury of university staff members in botany and education

Reference: Novak, Joseph D. "A Comparison of Two Methods of Teaching a College General Botany Course." Unpublished doctoral dissertation, University of Minnesota, 1957, p. 159.
University Microfilms Order No. 58-2159

Title: [RALPH SCIENCE ATTITUDE SCALE]

Factors: Attitudes about science

Format: Likert-type scale

Population: Upper elementary school children

Reliability: Computation of coefficient alpha indicated functional reliabilities

Validation: Construct validity supported through factor analysis

Reference: Ralph, Ruth Olson. "The Development and Analysis of an Instrument to Measure Attitudes About Science of Upper Elementary Pupils." Unpublished doctoral dissertation, Kent State University, 1972, Appendix.
University Microfilms Order No. 73-9252

Title: SCHWIRIAN SCIENCE SUPPORT SCALE

Factors: Science attitudes

Format: 60 Likert-type items

Population: Undergraduates at The Ohio State University. Also used with elementary school teachers.

Reliability: r = .837 (Split-half) based on the most discriminating 40 items
N = 513

Norms: See: Patricia M. Schwirian. "Characteristics of Elementary Teachers Related to Attitudes Toward Science." *Journal of Research in Science Teaching*, Vol. 6, No. 3:203-213, 1969.

Validation: Development and selection of items based upon Bernard Barber's contentions regarding the nature of science attitudes necessary to the growth and development of science in a society.

Reference: Eiss, Albert F. and Mary Blatt Harbeck. *Behavioral Objectives in the Affective Domain*, National Science Teachers Association, 1201 Sixteenth St., N.W., Washington, D.C. 20036, 1969, p. 36.
ED 028 101 MF $0.65 HC Not available

Title: INVENTORY OF SCIENCE ATTITUDES, INTEREST AND APPRECIATIONS

Factors: Affective outcomes of science teaching

Format: Part I - 50 statements reflecting attitudes about science
Part II - 21 statements concerning possible experience of respondent
Possible responses: Agree, disagree, no opinion

Population: Sixth grade students

Reliability: Not available

Norms: See dissertation N = 1518

Validation: Not available

Reference: Swan, Malcolm D. "An Exploratory Study of Science Achievement as it Relates to Science Curricula and Programs at the Sixth-Grade Level in Montana Public Schools." Unpublished doctoral dissertation, University of Montana, 1965, pp. 196-199.
University Microfilms Order No. 65-12980

Title: ATTITUDE SCALE

Factors: Generalized attitude toward science

Format: 80 items using 7 point Likert-type scale

Population: 9th and 10th graders

Reliability: r = 0.87 (K-R 20) N = 350

Validation: Criteria derived from literature provided bases for development of items.

Reference: Vitrogen, David. "A Method for Determining a Generalized Attitude Toward Science." Unpublished doctoral dissertation, New York University, 1965, Appendix.
University Microfilms Order No. 66-9525

Title: BIOLOGY ATTITUDE ASSESSMENT SCALE

Factors: Attitudes toward bioloty

Format: Five Likert-type items representing each of the 13 subdivisions of the affective domain as listed by Krathwohl, Bloom and Masia.

Population: Tenth grade biology students in schools of eastern Iowa and their teachers

Reliability: Not available

Norms: See dissertation

Validation: Instrument constructed by author with reference to the Krathwohl Taxonomy

Reference: Glass, Lynn William. "An Analysis of the Influence of Selected Teacher Behaviors Upon Development of Corresponding Student Behaviors." Unpublished doctoral dissertation, University of Iowa, 1970, p. 166.
University Microfilms Order No. 70-23,889

Title: [ATTITUDES TOWARD GENETICS]

Factors: Attitudes toward genetics; content, research, and social implication

Format: Semantic differential format using 6 concepts each with 18 adjective pairs

Population: College students

Reliability: Not available

Validation: Jury

Reference: Gross, Bernard Francis. "The Design of an Auto-Tutorial Genetics Course to Increase Scientific Literacy Among Nonscience Majors and its Evaluation Using a Science-Related Semantic Differential Instrument." Unpublished doctoral dissertation, Syracuse University, 1971, p. 149.
University Microfilms Order No. 72-6585

Title: CHEMISTRY PREFERENCE EVALUATION INSTRUMENT

Factors: Value orientation of respondent to theoretical, humanistic and technical applications of chemistry

Format: 24 sets of alternative statements (three alternatives in each set).

Population: Twelfth grade chemistry students and teachers in London, Ontario

Reliability:

		Students	Teachers
Humanistic scale	-	r = .85	.78
Theoretical scale	-	r = .90	.85
Technological scale	-	r = .77	.72
		N = 120	39

Validation: Content validity established through categorization of items by a panel of experts

Reference: Husten, Peter Henry. "A Study of Value Orientation as a Characteristic of Secondary School Students and Teachers of Chemistry and as a Factor in Learning." Unpublished doctoral dissertation, Michigan State University, 1971, Appendix.
University Microfilms Order No. 72-8705

Title: [ASTRONOMY ATTITUDE SCALE]

Factors: Attitudes toward astronomy

Format: 24 Likert-type items

Population: Elementary astronomy students at Oklahoma State University

Reliability: Established by method developed by Edwards. Each item found to discriminate between positive and negative attitudes between upper and lower quartiles at the .05 level of confidence.

Reference: Oines, Ronald K. "The Comparative Effectiveness of Individually Prescribed Instruction and the Lecture Demonstration Method to Achieve Behavioral Objectives for a Descriptive Astronomy Course." Unpublished doctoral dissertation, Oklahoma State University, 1971, p. 82.
University Microfilms Order No. 72-21,960

Title: ATTITUDE TOWARD BIOLOGY
1) Student
2) Instructor

Factors: Attitudes toward biology

Format: 15 Likert-type items on each instrument

Population: General biology students and instructors from junior colleges in Texas

Reliability: Student form r = .94 (alpha-coefficient)
Instructor form r = .79 (alpha-coefficient)
N = 29

Validation: Judges and factor analysis

Reference: Riggs, Julia Ree. "An Analysis of Student and Instructor Reactions to Biology and Selected Techniques of Biology Laboratory Instruction in Two-Year Colleges." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 92-94.
University Microfilms Order No. 73-18,488

Title: BIOLOGICAL SCIENCE ATTITUDE SCALE

Factors: Attitude toward biological science

Format: 32 statements with "Agree-Disagree" response scale

Population: Elementary education majors at Michigan State University

Reliability: r = .633 (Test-retest)
r = .86 (Split-half)

Validation: Items in large pool were evaluated by jury. Selection of items from pool based upon these evaluations.

Reference: Snitgen, Donald Albert. "A Study of the Attitude of Prospective Elementary School Teachers Toward Biological Science." Unpublished doctoral dissertation, Michigan State University, 1971, p. 136.
University Microfilms Order No. 72-8782

Title:	CLARKE SCIENCE INTEREST CHECKLIST
Factors:	Relative interest in three science areas; biological, earth and physical.
Format:	25 items, each consisting of three concepts representing three different areas of science. Respondent chooses the most interesting and the least interesting of the three concepts.
Population:	Intermediate grade students from rural, suburban and urban areas of Massachusetts
Reliability:	Not available N = 776
Validation:	Analysis of curriculum materials provided pool of items. Jury determined items for final instrument.
Reference:	Clarke, Cleveland Oliver. "A Determination of Commonalities of Science Interests Held by Intermediate Grade Children in Inner-City, Suburban and Rural Schools." Unpublished doctoral dissertation, Boston University, 1971, p. 155. University Microfilms Order No. 71-26,683

Title:	INTEREST INVENTORY
Factors:	Science interest level
Format:	Six parts: Part One - ranking of 10 elementary school subjects in order of student preference; Part Two - nine areas students could read about in library books; Part Three - ten possible occupations; Part Four - ten games and play objects; Part Five - ten articles commonly collected by children; Part Six - ten places students could visit. For Parts 2-6 respondents indicate degree of like-dislike on a five point scale.
Population:	Sixth graders in Wichita public schools
Reliability:	Instrument given three times to same students. Coefficients of correlation between results were: 1st and 2nd r = .714 2nd and 3rd r = .786 1st and 3rd r = .719

Norms: See dissertation

Validation: Not available

Reference: Downing, Carl E. "A Statistical Examination of the Relationship Among Elementary Science Achievement Gains, Interest Level Changes, and Time Allotment for Instructional Purposes." Unpublished doctoral dissertation, Oklahoma State University, 1963, pp. 118-121.
University Microfilms Order No. 64-8912

Title: STUDENT REACTION INVENTORY

Factors: Degree of interest of students in various areas of science covered in a science survey course

Format: First part focuses on general factors of interest in science and consists of 72 questions answerable by yes-no response.
Second part consists of a series of 150 words selected from the areas of natural sciences. Respondent indicates his degree of interest in each.

Population: Students at the Newark College of Rutgers University

Reliability: Part II: 50 words were identified. For each original word two corresponding words were selected. This process yielded three equivalent lists of 50 words each. Rank correlations were as follows:

First and second lists $r = .729$
Second and third lists $r = .725$ $N = 101$
First and third lists $r = .620$

Norms: See dissertation starting on p. 49

Validation: List of terms used agreed on by all course instructors

Reference: Leader, William. "The Expressed Science Interests of Students at the Conclusion of a College Science Survey Course and Their Relationship to Achievement in the Course." Unpublished doctoral dissertation, Columbia University, 1951, pp. 76-80.
University Microfilms Order No. 3357

Title: MEASUREMENT OF BEHAVIORALLY DEFINED INTERESTS: SCIENCE

Factors: Interest in science

Format: Respondent asked to react to each of 20 science related behaviors on 4 adjective pairs; Valuable - Worthless, Easy - Difficult, Exciting - Dull, Interesting - Boring.

Population: 10th and 11th grade students

Reliability: Test-retest procedures indicate scale in present form did not possess acceptable reliability for respondents of this age group.

Validation: Adapted from *The Behaviorally-Defined Academic-Vocational Involvement Scale* copyrighted by: John W. Butzow, Jr., Duane O. Rubadeau and Clarence M. Williams, 1968.

Reference: Lowe, Charles Wesley. "An Investigation of Relationships Between Semantic Differential Measures of Interest in Science and Achievement in Science at the High School Level." Unpublished doctoral dissertation, The University of Rochester, 1972, p. 81. University Microfilms Order No. 72-28,813

Title: SCIENCE ACTIVITIES CHECKLIST

Factors: Interest in biological, earth, and physical science

Format: 48-item checklist

Population: Seventh and eighth grade students

Validation: Revised from the Reed activities checklist (See P.140). Judges provided content validity. Factor analysis used for empirical validity.

Reference: Skinner, Ray, Jr. and Robert S. Barcikowski. "Measuring Specific Interest in Biological, Physical and Earth Sciences in Intermediate Grade Levels." *Journal of Research in Science Teaching*, Vol. 10, No. 2:153-158, 1973.

Section 2: Instruction and Teaching

Instrument Title	Level	Page
Attitudes Toward Science Classes or Instruction		
How Much Do You Like	J	130
Student Attitude Toward Science	S	130
How I Feel, Form OZ	E	131
Indoor-Outdoor Preference Appraisal	J	131
[Milson Attitude Scale]	S	132
Science Attitude Inventory	S	133
[DeLuca Attitude Scale]	C	133
[Henson Attitude Scale]	J	134
Science Attitude Scale	E	134
Attitudes Toward Teaching Science		
Attitude Scale	C	135
Science Related Semantic Differential	C	135

Title: HOW MUCH DO YOU LIKE

Factors: Attitudes toward science class

Format: 5 items each having a 7 point response scale

Population: Eighth grade students enrolled in physical science classes

Reliability: Not available

Norms: See dissertation N = 96

Validation: Not available

Reference: Clark, Billy M. "An Experiment in Cultivating Creative Thinking Abilities in the Classroom." Unpublished doctoral dissertation, Iowa State University, 1968, p. 84.
University Microfilms Order No. 68-14,778

Title: STUDENT ATTITUDE TOWARD SCIENCE

Factors: Student acceptance of 1) text material, 2) course content, 3) laboratory work, 4) interest in the course, 5) involvement and 6) satisfaction of perceived needs.

Format: 72 statements using a Likert-type response scale

Population: 10th grade secondary school students taking the "General Course" science program in Manitoba schools

Reliability: Not available

Norms:

Factor	Neutral Score		
1.	39	$\bar{X}$ = 44.2	S.D. = 9.5
2.	36	$\bar{X}$ = 38.5	S.D. = 6.7
3.	42	$\bar{X}$ = 41.0	S.D. = 6.2
4.	51	$\bar{X}$ = 54.4	S.D. = 12.2
5.	33	$\bar{X}$ = 38.6	S.D. = 4.9
6.	15	$\bar{X}$ = 16.0	S.D. = 3.3
Total Test		$\bar{X}$ =232.8	S.D. = 32.2

N = 872

Validation: Not available

Reference: Hedley, Robert Lloyd. "Student Attitude and Achievement in Science Courses in Manitoba Secondary Schools." Unpublished doctoral dissertation, Michigan State University, 1966, pp. 162-166.
University Microfilms Order No. 67-1635

Title: HOW I FEEL, FORM OZ

Factors: Scale I: Attitude toward science class and science
Scale II: Attitude about science class

Format: Thirty item, forced-choice instrument

Population: Second and third grade students

Reliability: Internal reliability of each scale was computed from item mean values for the total group using Cronbach's coefficient alpha.
Scale I = .564 Scale II = .505 N = 75

Validation: Corrected correlations with IQ scores were essentially zero. It therefore measures something which is independent of IQ.

Reference: See Appendix p. 244

Title: INDOOR-OUTDOOR PREFERENCE APPRAISAL

Factors: Learners preference for the outdoor environment

Format: 46 multiple-choice items

Population: Eighth and ninth grade students

Reliability: r = .85 (K-R 20)
N = 318

Norms: $\overline{X}$ = 30.48
S.D. = 7.39

Validation: Jury determined face validity

Reference: McNamara, Eugene Stephen. "A Comparison of the Learning Behaviors of Eighth and Ninth Grade ESCP Earth Science Students: One-half Experiencing Laboratory Investigations in the Indoor Environment, the Other Half Experiencing Laboratory Investigations in the Outdoor Environment." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 136.
University Microfilms Order No. 72-13,895

Title: [MILSON ATTITUDE SCALE]

Factors: Attitudes toward science class, laboratory, school, science teacher and topic

Format: Four concepts with 12 bipolar adjective scales for each concept

Population: Slow learners in secondary school

Reliability: Test-retest reliabilities varied widely between the four concepts.

Norms: Provided in dissertation

Validation: Face validity assumed

Reference: Milson, James Lee. "The Development and Evaluation of Physical Science Curriculum Materials Designed to Improve the Attitudes of the Secondary School Slow Learner." Unpublished doctoral dissertation, The University of Texas at Austin, 1970, p. 234.
University Microfilms Order No. 71-165

Title: SCIENCE ATTITUDE INVENTORY (Three Versions)

Factors: Attitudes toward science courses; physics, chemistry, biology.

Format: 40 Likert-type items

Population: Secondary school students in northeastern Massachusetts

Reliability: r = .45 (K-R 20)
r = .73 (Test-retest)

Validation: Items developed from an analysis of opinion statements obtained from 250 high school students. Predictive validity established by correlation with respondents' choices of science course the year following the study.

Reference: Poole, William F., Jr. "Factors Related to Enrollment in Secondary School Physics." Unpublished doctoral dissertation, Boston School of Education, 1972, p. 149.
University Microfilms Order No. 72-25,456

Title: [DELUCA ATTITUDE SCALE]

Factors: Attitudes toward seven concepts representing particular phases of a geology laboratory course; the university; general aspects of the geology course.

Format: Thirteen concepts each with 10 adjective pairs in semantic differential format

Population: Students enrolled in introductory geology at The University of Oklahoma

Reliability: Not available

Norms: See page 84 of dissertation

Validation: Not available

Reference: DeLuca, Frederick Peter. "The Development and Implementation of Structured Inquiry Methods and Materials for an Introductory Geology Laboratory Course and Their Effectiveness as Compared to the Traditional Course." Unpublished doctoral dissertation, The University of Oklahoma, 1970, p. 178.
University Microfilms Order No. 71-12,564

Title: [HENSON ATTITUDE SCALE]

Factors: Attitudes toward school, science, learning earth science, reading earth science, earth science experiments, earth science teacher and earth science classmates.

Format: Semantic differential form with seven concepts each using nine adjective pairs

Population: Ninth grade students from upper, middle and lower socio-economic groups who were enrolled in Oklahoma City public schools

Reliability: Not available

Validation: Not available

Reference: Henson, Stanley Joe. "A Study of the Science Achievement of Earth Science Curriculum Project, Students from Different Socio-Economic Areas." Unpublished doctoral dissertation, Oklahoma State University, 1970, p. 60.
University Microfilms Order No. 71-11,165

Title: SCIENCE ATTITUDE SCALE

Factors: Attitude toward subject of science

Format: 33 Likert-type items

Population: Sixth grade students

Reliability: Reliability coefficient alpha = .90 N = 115

Norms: See dissertation

Validation: Jury of four

Reference: Shrigley, Robert L. "Handmade Versus Commercial Equipment in Elementary School Science." Unpublished doctoral dissertation, Pennsylvania State University, 1968, Appendix.
University Microfilms Order No. 69-9807

Title: ATTITUDE SCALE

Factors: Attitudes toward teaching and learning science

Format: 20 items with weighted values. Agree responses are totalled for score.

Population: Elementary education majors without science background

Reliability: r = .93 (Test-retest method) N = 226

Validation: Items selected from pool of 200 through Q-sort technique using 100 respondents.

Reference: Dutton, Wilbur H. and Lois Stephens. "Measuring Attitudes Toward Science." School Science and Mathematics, Vol. 63:43-49, 1963.

Title: SCIENCE RELATED SEMANTIC DIFFERENTIAL

Factors: Attitude toward teaching science

Format: 12 concepts each with 15 bipolar adjective scales arranged in semantic differential form

Population: Student teachers in secondary school science at The University of Colorado

Validation: Results examined for factor structure

Reference: James, Helen Hope. "Effects of Three Supervisory Methods Upon the Development of a Teaching Strategy Among Science Student Teachers." Unpublished doctoral dissertation, The University of Colorado, 1970, p. 75 and 173-175.
University Microfilms Order No. 70-23,724

Section 3: Science and Science Instruction or Teaching

Instrument Title	Level	Page
Science Instruction Attitude Inventory	C	137
[Conner Attitude Scale]	J	137
Student Questionnaire	J	138
Affective Self-Report Instrument	J	138
[Hecht Science Attitude Scale]	J	139
[School and Science Attitudes Scale]	S	139
Attitudes Toward Science and Science Teaching	C	140
Reed Science Activity Inventory	S	140
Biology Student Behavior Inventory	S	141
[Wernegreen Science Attitude Scale]	C	141
[Zurhellen Attitude Scale]	C	142

Title: SCIENCE INSTRUCTION ATTITUDE INVENTORY

Factors: Attitude toward science and science instruction

Format: 30 Likert-type statements

Population: Students enrolled in a college-level general education course in chemistry

Reliability: r = .776 (Test-retest)

Validation: Jury

Reference: Ault, Frederick Keith. "Cognitive Style, Attitude Toward Science, and Sex on Success with Programmed Instruction on Kinetic Theory." Unpublished doctoral dissertation, Indiana University, 1970, p. 117.
University Microfilms Order No. 71-11,361

Title: [CONNER ATTITUDE SCALE]

Factors: 9 attitude factors toward science, scientists and science class

Format: Semantic differential with five concepts using 12 bipolar adjective pairs

Population: 8th grade science students in inner-city schools

Reliability: r = .45 to .83 (K-R 20) for scale factors

Reference: Conner, James Lewis. "Effects of Modularized Science Instruction on Student Achievement and Attitudes in Inner-City Junior High Schools." Unpublished doctoral dissertation, University of Houston, 1972, p. 94.
University Microfilms Order No. 72-32,691

Title: STUDENT QUESTIONNAIRE

Factors: Student attitudes toward teacher and learning science

Format: 34 Likert-type items

Population: Junior high school students

Reliability: Not available

Validation: Not available

Reference: See Appendix p. 307.

Title: AFFECTIVE SELF-REPORT INSTRUMENT

Factors: Students interests, appreciation, attitudes, and values held toward science

Format: 42 Likert-type items

Population: Eighth grade students

Reliability: r = .85
N = 154

Validation: Observational instrument for teacher. Assessment of same student behaviors also developed. Face validity assumed for both instruments.

Reference: Hackett, Jay K. "An Investigation of the Correlation Between Teacher Observed and Student Self-Reported Affective Behavior Toward Science." Unpublished doctoral dissertation, University of Northern Colorado, 1972, p. 76.
University Microfilms Order No. 72-23,805

Title: [HECHT SCIENCE ATTITUDE SCALE]

Factors: Attitudes on six concepts; Scientists, Science research done by scientists, High school science teachers, High school science courses, Experiments done in high school.

Format: Semantic differential form using 16 bipolar adjective scales

Population: Students enrolled in Introductory Physical Science (ninth grade)

Reliability: r = .80 (Test-retest)

Validation: Not available

Referenee: Hecht, Alfred Roland. "A Semantic Differential Evaluation of Attitudinal Outcomes of Introductory Physical Science." Unpublished doctoral dissertation, University of Illinois, 1970, p. 99.
University Microfilms Order No. 71-5123

Title: [SCHOOL AND SCIENCE ATTITUDES SCALE]

Factors: Attitudes toward college, senior year of high school, science and mathematics and several other school-related concepts.

Format: Semantic differential

Population: Senior high school students in St. Louis, Missouri

Reliability: Not available

Validation: Face validity

Reference: Jones, James Ray. "Evaluation of the Impact of the Student Science Training Program Under a Selected Group of Students." Unpublished doctoral dissertation, St. Louis University, 1970, p. 49.
University Microfilms Order No. 71-3269

Title: ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

Factors: Changes in attitude as a result of the introduction of some experimental variable:
(1) Toward Science (2) Toward Teaching Science

Population: Elementary teachers, elementary education majors and college freshmen

Reliability: Split-half (Spearman-Brown correction)
(1) r = .88 (2) r = .84 N = 154

Norms: Means: (1) 62.18 (Max. = 80)
(2) 54.78 (Max. = 80) N = 45

Validation: Internal consistency

Reference: See Appendix p. 248.

Title: REED SCIENCE ACTIVITY INVENTORY

Factors: 1) Pupil science interest
2) Teacher behaviors of warmth, demand and utilization of intrinsic motivation

Format: Part I: Lists 70 possible student behaviors related to interest in science. Respondent indicates the degree to which he has participated in each on a six-point scale.

Part II: Lists 49 possible teacher classroom behaviors. Respondent indicates on a five-point scale the degree to which his teacher exhibits each behavior.

Population: Secondary school science students

Reference: Reed, Horace B. "Pupil Interest in Science as a Function of the Teacher Behaviors of Warmth, Demand, and Utilization of Intrinsic Motivation." Unpublished doctoral dissertation, Harvard University, 1959.

Instrument available: Brogan, Joseph John. "Teacher Behavior, Classroom Verbal Interaction and Pupil's Science Interest and Achievement: An Investigation of Teacher Effectiveness in High School Biology and Chemistry Teaching Using the Flanders Method of Interaction Analysis and a Pupil Science Inventory Within Experimentally Adjusted Contrasting Classroom Climates." Unpublished doctoral dissertation, New York University, 1971, p. 165.
University Microfilms Order No. 71-28,526

Title: BIOLOGY STUDENT BEHAVIOR INVENTORY

Factors: Science attitudes, interests: 1) curiosity, 2) openness, 3) satisfaction, 4) responsibility

Format: Several types of items are used including:
1) Situations are explained and students asked to indicate what they might do in the given situation.
2) Students are asked the extent to which they agree with a stated opinion.

Population: Tenth grade biology students

Reliability: Split-half corrected N = 1,153
1) .67 2) .68 3) .71 4) .37

Validation: Content validity by panel of judges, item validity through internal consistency, and concurrent validity by three different methods.

Reference: See Appendix p. 285.

Title: [WERNEGREEN SCIENCE ATTITUDE SCALE]

Factors: Attitudes toward; Science teachers, myself as a science student, scientists, mathematics and science.

Format: Semantic differential consisting of 5 concepts and 30 adjective-pairs for each concept.

Population: Students enrolled in a college physical science course

Reference: Wernegreen, Johannes Oscar. "An Exploratory Study of Changes in Concepts as Measured by a Semantic Differential Instrument During a College Physical Science Course for Nonscience Majors." Unpublished doctoral dissertation, University of Illinois, 1971, Appendix.
University Microfilms Order No. 72-7104

Title: [ZURHELLEN ATTITUDE SCALE]

Factors: Attitudes toward five concepts: My Ideal Teacher, My Ideal Student, My Ideal Self, My Real Self and My ESCP Institute Director.

Format: Semantic differential using twenty-five adjective pairs for each of the five concepts

Population: In-Service teachers and their institute leaders

Reliability: Not available

Norms: See dissertation

Validation: Not available

Reference: Zurhellen, Joan Harris. "An Evaluation of Attitude Changes Among Science Teachers During an ESCP In-Service Institute." Unpublished doctoral dissertation, The University of Tennessee, 1970, p. 178.
University Microfilms Order No. 71-7699

Section 4: Conservation, Drug Abuse, Environment, Radioactivity, Sex

Instrument Title	Level	Page
Conservation		
Attitude Toward Conservation	S-C	144
[Conservation Attitude Inventory]	C	144
[Attitudes and Beliefs Concerning Conservation]	S-C	145
Laug Test of Attitudes Toward Conservation	C	145
Environment		
Attitude Inventory for Environmental Quality	S	146
What I Believe About Pollution	E	146
Inventory of Societal Issues	S	147
Others		
[Attitudes Toward Drug Abuse]	C	147
Attitude Toward Radioactivity Scale	C	148
[Attitudes Toward Sex]	S	148

Title: ATTITUDE TOWARD CONSERVATION

Factors: Attitudes about conservation of natural resources

Format: 64 Likert-type items

Population: High school, college, and adult groups

Reliability: Not available

Norms: See dissertation

Validation: Not available

Reference: George, Robert W. "A Comparative Analysis of Conservation Attitudes in Situations Where Conservation Education is a Part of the Educational Experience." Unpublished doctoral dissertation, Michigan State University, 1966, p. 128.
University Microfilms Order No. 66-14,123

Title: [CONSERVATION ATTITUDE INVENTORY]

Factors: Attitudes toward conservation

Format: 116 Likert-type items

Population: College juniors and seniors

Reliability: A cluster analysis of items yielded 16 clusters with K-R 20 reliabilities ranging from .40 to .93.

Validation: Not available

Reference: Hoover, Kenneth H. and Richard E. Schutz. "Conservation Attitudes." Science Education, Vol. 47, No. 1:63-68, February, 1963.

Title: [ATTITUDES AND BELIEFS CONCERNING CONSERVATION]

Factors: Attitudes toward conservation and beliefs concerning conservation knowledge

Format:
a) 36 Likert-type items
b) 26 items when respondent is asked to respond on a 4 point frequency scale with fifth option "I don't know"

c) 8 yes-no items (Gultman technique)

Population: Student and adult residents of two Colorado communities

Reliability: Not available

Validation: Not available

Reference: Solid, Myron Lee. "The Use of a Comparative Analysis as an Evaluation of a Junior High School Conservation Program." Unpublished doctoral dissertation, University of Colorado,1971, p. 128.
University Microfilms Order No. 72-3706

Title: LAUG TEST OF ATTITUDES TOWARD CONSERVATION

Factors: Attitudes toward conservation

Format: 66 Likert-type items

Population: College freshmen

Reliability: r = .94 (Spearman-Brown)

Validation: Not available

Reference: Whiteman, Eldon E. "A Comparative Study of the Effect of a Traditional and a Specially Designed College Course in Biology Upon Conservation Attitudes." Unpublished doctoral dissertation, Michigan State University, 1965, pp. 108-112.
University Microfilms Order No. 65-14,289

Instrument developed by George M. Laug, New York State University, College of Buffalo.
See: Laug, George M. "A Study of Expressed Attitudes of Prospective Teachers Taking Part in Practical Conservation Activities." Unpublished doctoral dissertation, Syracuse University, 1960.
University Microfilms Order No. 60-2609

Title: ATTITUDE INVENTORY FOR ENVIRONMENTAL QUALITY

Factors: Attitudes toward environmental quality

Format: Semantic differential using 12 concepts each with 10 bipolar adjectives

Population: 11th grade students from farm, suburben and urban areas of Pennsylvania

Reliability: Not available

Validation: Face validity

Reference: Eaton, John Lawrence. "Environmental Attitude and Health Knowledge of Tenth Grade High School Students." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 78.
University Microfilms Order No. 71-28,684

Title: WHAT I BELIEVE ABOUT POLLUTION

Factors: Attitudes toward problems of environmental pollution

Format: 20 Likert-type items

Population: Fourth, fifth and sixth graders

Reliability: r = .79 (Split-half)

Validation: Jury

Reference: Holloway, Mildred Azelle Evans. "Cognitive and Affective Orientations of Elementary School Children Toward Air, Water, and Soil Pollution." Unpublished doctoral dissertation, University of Alabama, 1972, p. 279.
University Microfilms Order No. 72-17,107

Title: INVENTORY OF SOCIETAL ISSUES

Factors: Seven interpretable factors were found relating to environmental issues and society and the individual's role in these issues.

Format: 60 Likert-type items

Population: A representative sample of seniors in the public high schools of Oregon

Reliability:
a) Total instrument reliabilities;
   Cronbach alpha r = 0.647
   Spearman-Brown Prophesy formula r = 0.768
   Pearson-Product-Moment Correlation r = 0.624
b) Reliabilities of scales ranged from 0.48 - 0.85 using Spearman-Brown Prophesy formula
N = 304

Norms: See pages 107-121 of dissertation

Validation: A pool of items was generated following certain established ground rules. From a series of administrations of the pool items and their analysis a pool of 100 items were selected. These were evaluated by professors from sciences, humanities, and social sciences. Factor analysis resulted in selection of 60 items for final version.

Reference: Steiner, Robert L. "A Factor Analytic Study of the Attitudes of Oregon High School Seniors Toward Socially Significant Science-Related Issues." Unpublished doctoral dissertation, Oregon State University, 1971, pp. 143-148.
University Microfilms Order No. 71-19,912

Title: [ATTITUDES TOWARD DRUG ABUSE]

Factors: Attitudes toward eight drug abuse concepts

Format: Semantic differential format using eight concepts and ten adjective pairs

Population: College students

Reliability: Not available

Validation: Not available

Reference: Blackwell, James Toy, Jr. "The Effects of a Self-directed Drug Abuse Education Program on Attitudes of College Students." Unpublished doctoral dissertation, Auburn University, 1972, p. 122.
University Microfilms Order No. 72-19,033

Title: ATTITUDE TOWARD RADIOACTIVITY SCALE

Factors: Beliefs about specific areas of radioactivity

Format: 20 Likert-type statements

Population: Undergraduate students of the University of Texas at Austin

Reliability: r = .83 (coefficient alpha)

Validation: Judges selected items from a pool. Information on discrimination of items in pool was also used by author.

Reference: Crater, Harold L., Jr. "The Identification of Factors Influencing College Students' Attitudes Toward Radioactivity." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 74.
University Microfilms Order No. 73-7537

Title: [ATTITUDES TOWARD SEX]

Factors: Attitudes toward sex concepts

Format: Semantic differential form using nine concepts each with ten corresponding bipolar adjectives.

Population: High school seniors

Reliability: Not available N = 67

Validation: Face validity

Reference: Wallace, Robert Clayton. "Sex Education Knowledge, Verbal Interaction and Attitudes: An Exploratory Study in High School Human Biology Classes." Unpublished doctoral dissertation, University of Illinois, 1970, p. 122.
University Microfilms Order No. 71-14,979

CHAPTER FIVE

KNOWLEDGE OF THE NATURE OF SCIENCE

Instruments described in this chapter measure the respondent's understanding and knowledge of the nature of the scientific enterprise. Instruments included measure scientific literacy, knowledge of the methods and processes used by scientists, and relationships between science, technology and society. The educational level of the targeted respondent-group is indicated by a code letter (see page 5).

Instrument Title	Level	Page
[Beliefs About Science]	S	150
A Measurement of Knowledge About Science and Scientists	S	150
Views of Science Scale	C	151
Information Test	C	151
Iowa Science and Culture Study Achievement Test	S	152
The Nature of Science Scale	C	152
Test of Social Aspects of Science	S	153
Test on the Methodology of Science	C	153
Opinion Inventory on Relationships Between Science, Technology, and Society	S	154
Wisconsin Inventory of Science Processes	S-C	154
The Abridged Scientific Literacy Instrument	C	155
Scientific Literacy Test	S	155
Appraisal of Methods and Processes of Scientists	C	156
Welch Science Process Inventory, Form D	S-C	156
The Methods and Procedures of Science: An Examination	S	157

Title: [BELIEFS ABOUT SCIENCE]

Factors: Knowledge related to: Science and scientists, science-society interrelationships, the atom and atomic energy

Format: Three subtests each consisting of 30 multiple-choice items

Population: 12th grade social studies students and high school chemistry students (grades 10-12)

Reliability: Internal consistency relabilities on posttest. Subtests range from .502 to .818 and total test reliabilities range from .780 to .903.
N = 183

Validation: Not available

Reference: Agin, Michael Lawrence. "The Feasibility of Teaching Science Via a Socio-historical Approach." Unpublished doctoral dissertation, The University of Wisconsin, 1970, Appendix.
University Microfilms Order No. 71-280

Title: A MEASUREMENT OF KNOWLEDGE ABOUT SCIENCE AND SCIENTISTS

Factors: Knowledge about science and scientists as related to the objectives of the course: Harvard Project Physics.

Format: 33 multiple-choice items and 68 agree-disagree items

Population: Nationwide sample of high school physics students

Reliability: Not available

Validation: Items chosen from the "Test on Understanding Science" and the "Science Process Inventory" on the basis of performance on each item of students enrolled in Harvard Project Physics compared to the performance of a control group on the same items.

Reference: Aikenhead, Glen Stirton. "The Measurement of Knowledge about Science and Scientists: An Investigation into the Development of Instruments for Formative Evaluation." Unpublished doctoral dissertation, Harvard University, 1972, p. 256.
University Microfilms Order No. 72-21,423

Title: VIEWS OF SCIENCE SCALE

Factors: Views of aspects of the scientific enterprise to which various scientists and philosophies of science give different emphases

Format: 23 term-pairs with five point response scale

Population: Secondary school biology teachers in central Ohio

Reliability: r = .76 (Hoyt)
r = .93 (Test-retest)
N = 79

Reference: Best, Effie Deland. "An Exploratory Study of the Correlates of Student Decision Making in the Secondary School Biology Laboratory." Unpublished doctoral dissertation, The Ohio State University, 1970, p. 257.
University Microfilms Order No. 71-17,959

Title: INFORMATION TEST

Factors: Knowledge of names and terms from each of the two "cultures"; science and humanities

Format: Two sets of twenty matching items; one set for science, one for humanities

Population: Public high school teachers in Connecticut

Reliability: Not available N = 118

Validation: Three authorities in each of the two fields asked to construct a 20-item test. The final test constructed from these pilot tests.

Reference: Clark, William Austin. "An Identification of the Gap Between the Scientific Culture and the Humanistic Culture in the Secondary School." Unpublished doctoral dissertation, The University of Connecticut, 1970, p. 85.
University Microfilms Order No. 71-15,969

Title: IOWA SCIENCE AND CULTURE STUDY ACHIEVEMENT TEST

Factors: Understanding of science as related to culture

Format: 50 multiple-choice items

Population: 11th and 12th grade students

Reliability: r = .63 (Pre and posttest correlation using Pearson-product-moment)
N = 21

Validation: Correlation of scores with published instruments which were also used in study

Reference: Cossman, George W. "The Effects of a Course in Science and Culture Designed for Secondary School Students." Unpublished doctoral dissertation, University of Iowa, 1967, p. 96.
University Microfilms Order No. 68-913

Title: THE NATURE OF SCIENCE SCALE

Factors: Understanding of the nature of science

Format: 29 statements using Likert-type scale

Population: Science and philosophy majors at Stanford University and San Jose College

Reliability: r = .72 (Split-half)
N = 97

Validation: Based on model developed by author; items evaluated by panel

Reference: Kimball, Merritt E. "Understanding the Nature of Science: A Comparison of Scientists and Science Teachers." *Journal of Research in Science Teaching*, Vol. 5:110-120, 1967.

Title: TEST OF SOCIAL ASPECTS OF SCIENCE

Factors: Understanding of the interaction of science and society

Format: 52 Likert-type items

Population: High school sophomores

Reliability: r = .71 (K-R 20 with agree responses scored as correct)
N = 140

Norms: See dissertation

Validation: Twelve-member jury

Reference: Korth, Willard W. "The Use of the History of Science to Promote Student Understanding of the Social Aspects of Science." Unpublished doctoral dissertation, Stanford University, 1968, pp. 55-60.
University Microfilms Order No. 68-15069

Title: TEST ON THE METHODOLOGY OF SCIENCE

Factors: Understanding of the methodology of science

Format: 55 multiple-choice items (final versions)

Population: In-service science teachers

Reliability: r = .63 (K-R 20) N = 53

Norms: $\overline{X}$ = 24.98 S.D. = 5.50

Validation: Jury comprised of 10 authorities on the philosophy of science

Reference: Meinhold, Russell. "An Analysis of the Scores of Science Teachers on a Test of the Methodology of Science." Unpublished doctoral dissertation, 1961, pp. 129-136.
University Microfilms Order No. 61-5424

Title: OPINION INVENTORY ON RELATIONSHIPS BETWEEN SCIENCE, TECHNOLOGY, AND SOCIETY

Factors: Understanding of:
I) Interactions of science, technology and society,
II) Science as a social institution,
III) Social consequences of science and technology

Format: Part I - 15 statements
Part II - 20 statements
Part III - 8 statements
Respondent indicates agreement, disagreement or uncertainty about each statement

Population: High school chemistry students

Reliability: Alpha coefficients of internal consistency:
Part I - r = .72
Part II - r = .41 Total r = .78
Part III - r = .57

Validation: Not available

Reference: Milkent, Marlene Marie. "The Development and Evaluation of Supplementary Chemistry Curriculum Materials Reflecting Relationships Between Science, Technology, and Society." Unpublished doctoral dissertation, The University of Texas, 1971, p. 198.
University Microfilms Order No. 72-19,631

Title: WISCONSIN INVENTORY OF SCIENCE PROCESSES

Factors: Knowledge of the scientific enterprise

Format: 93 statements; respondent asked to judge whether each is an accurate or inaccurate statement.

Population: Twelfth grade students and teachers

Reliability: r = .82

Norms: Students $\overline{X}$ = 54.2
Teachers $\overline{X}$ = 66.9

Validation: Not available

Reference: Dr. Milton O. Pella
The Scientific Literacy Research Center
The University of Wisconsin
Madison, Wisconsin

Title: THE ABRIDGED SCIENTIFIC LITERACY INSTRUMENT

Factors: Attitudes toward science and understanding of interrelationships in science

Format: 34 situation-establishing items with seven-point scale for response

Population: High school graduates enrolled as college freshmen

Reliability: Not available

Norms: Not available N = 358

Validation: 36-member jury participated in selection of items for final version of instrument.

Reference: Richardson, John S. and Showalter, Victor. "Effects of a Unified Science Curriculum on High School Graduates." The Ohio State University, 1967, pp. 59-65.
ED 024 593 MF $0.65 HC $6.58 105 pp.

Title: SCIENTIFIC LITERACY TEST

Factors: Awareness, acceptance of values, and preference for values

Format: 86 Likert-type items

Population: Secondary school biology students

Reliability: r = .89 (Split-half)

Validation: Not available

Reference: Schock, Norville H. "An Analysis of the Relationship Which Exists Between Cognitive and Affective Educational Objectives in Selected Biology Classrooms of Wayne County, Michigan." Unpublished doctoral dissertation, Wayne State University, 1971, p. 161.
University Microfilms Order No. 72-14,617

Title: APPRAISAL OF METHODS AND PROCESSES OF SCIENTISTS

Factors: Knowledge of science and methods and processes of science

Format: 33 multiple-choice items

Population: College students

Reliability: r = .76 (Method not indicated)

Validation: Opinion of experts

Reference: Smith, Melvin Ouston. "A Comparison of Two Laboratory Methods for the Teaching of General Physical Science at the College Level: Vicarious Experimentation Versus Conventional Experimentation." Unpublished doctoral dissertation, The Pennsylvania State University, 1971, p. 116.
University Microfilms Order No. 72-9530

Title: WELCH SCIENCE PROCESS INVENTORY, FORM D
(Earlier Form C also available)

Factors: Achievement of science process goals

Format: Respondent asked whether he agrees or disagrees with each of 135 items

Population: High school students and adults

Reliability: r = .86 (K-R 20) N = 171

Norms: $\overline{X}$ = 103.78 S.D. = 13.10 Range 33-132 N = 1058

Validation: Content validity established by opinion of experts

Reference: Dr. Wayne Welch
330 Burton Hall
The University of Minnesota
Minneapolis, Minnesota 55455

Title:	THE METHODS AND PROCEDURES OF SCIENCE: AN EXAMINATION
Factors:	Assesses student understanding of aspects of the methods and procedures reflected in a scientist's attack on a problem
Format:	Instrument consists of 50 statements. Respondent chooses from among five words or phrases the one that best characterizes the information in each statement.
Population:	Students in grades 9 through 12
Reliability:	r = .80 (K-R 20) N = 476
Norms:	$\overline{X} = 18.9$ S.E. = 0.3
Validation:	Instrument critiqued by approximately 20 science educators
Reference:	See Appendix p. 255.

CHAPTER SIX

PROFESSIONAL PRACTICES AND CONCERNS

The instruments in the first group seek student, teacher or teacher supervisor response to a series of items reflecting various teaching practices. The response is based upon his perception of the teaching carried on in the teacher's classroom. The second category includes descriptions of instruments which measure student or teacher attitudes or beliefs about certain classroom practices or science curricula. Instruments in the third section assess various aspects of supervision and evaluation in science; the supervisor's role, the teacher's perception of the supervisor, and the teacher's opinion of self-evaluation. Other instruments include inventories and checklists of course content and facilities for teaching science, and teacher's expectations of students.

Section 1: Measurement of Classroom Practices

Instrument Title — Page

Elementary Science

Student Perception Form; Teacher Perception Form 160
Contemporary Practices in Teaching Science 160
Level of Adoption Scale for Science Teaching Innovations 161
Pupil Control Ideology Form; Perceived Pupil Control Ideology Form 161
Ideal Classroom Environment; Actual Classroom Environment; Students' Perceived Classroom Environment 162
Science Teaching Information Questionnaire 163

Secondary Science

Biology Laboratory Activity Checklist 163
Biology Activity Report 164
Checklist for Assessment of Science Teachers 165
Knowledge Test of the Procedure for Selected Teaching Skills 165
Inservice Institute Questionnaire 166
Questionnaire for Principal, Supervisor, Curriculum Coordinator, etc. 166
Science Classroom Activity Checklist 166
Biology Classroom Activity Checklist 167

Instrument Title Page

Secondary Science

Student-Teacher Participation Checklist 168
Procedural Behavior Instrument: Student Perception; Teacher Perception 169
Verbal Behavior Checklist: Student Perception; Teacher Perception 169
Science Classroom Activity Checklist 170
Student Checklist 171

Student Teaching

Student-Teaching Evaluation Scale 172

College Biology

Survey of Student Perception of Course and College 172

Title: STUDENT PERCEPTION FORM; TEACHER PERCEPTION FORM

Factors: Perceptions of classroom activities and student and teacher roles

Format: Each consists of 9 multiple-choice items

Population: Elementary school students

Validation: Developed by Science Curriculum Improvement Study, University of California

Reference: Baker, Robert Morris. "A Study of the Effects of a Selected Set of Science Teaching Materials (Elementary Science Study) on Classroom Instructional Behaviors." Unpublished doctoral dissertation, The University of Rochester, 1970, p. 98.
University Microfilms Order No. 71-1439

Title: CONTEMPORARY PRACTICES IN TEACHING SCIENCE

Factors: The degree to which teaching practices are used and the teachers opinion of the soundness of the practices

Format: 36 science teaching practices; Respondent reacts to each on two response scales:
"I follow this practice": Frequently - usually - rarely or never (3 possible choices)
"I think this practice is": sound - open to question (4 possible choices)

Population: Elementary and junior high school students

Reference: Contemporary Practices in Teaching Science in Elementary and Junior High. Cooperative Educational Research Laboratory, Inc., 540 West Frontage Road, Box 815, Northfield, Illinois 60093. 1968, p. 5.

Title: LEVEL OF ADOPTION SCALE FOR SCIENCE TEACHING INNOVATIONS

Factors: Identifies the level at which innovative investigations have been adopted; awareness, interest, evaluation, trial, adoption.

Format: Ten investigations are described. Teachers indicate which one of seven statements best reflects his level of awareness or utilization of the investigation.

Population: Elementary school teachers K - 6

Reliability: $r = .65$ (Test-retest correlation)
$N = 94$

Validation: Content validity established by comparing instrument items with experiences included in an inservice program.

Reference: See Appendix p. 262.

Title:
1) PUPIL CONTROL IDEOLOGY FORM
2) PERCEIVED PUPIL CONTROL IDEOLOGY FORM

Factors:
1) Preference of teachers towards forms of control on a custodial-humanistic continuum
2) Perception by student teachers of the cooperating teachers pupil control ideology

Format: 20 item instrument using Likert-type scale responses

Population: Senior elementary education majors at Oklahoma State University

Reliability: Split-half technique using Pearson-product-moment correlation $r = .91$

Norms: Pretest $\overline{X} = 40.73$ S.D. = 5.38

Validation: Principals identified two groups of teachers subjectively; most custodial and most humanistic. The PCI given to both groups yielded a t-test difference significant at the .01 level.

Reference: Roberts, Richard Arland. "The Relationship Between the Change in Pupil Control Ideology of Student Teachers and the Student Teachers Perception of the Cooperating Teachers Pupil Control Ideology." Unpublished doctoral dissertation, Oklahoma State University, 1969, p. 54.
University Microfilms Order No. 70-21,468

Title: 1) IDEAL CLASSROOM ENVIRONMENT 2) ACTUAL CLASSROOM ENVIRONMENT 3) STUDENTS' PERCEIVED CLASSROOM ENVIRONMENT

Factors:
1) The practices that teachers perceive as ideal for implementation in their science classes
2) The extent to which teachers were actually able to implement the ideal practices
3) Students' perceptions of their classroom

Format: Each form consists of 28 items; response on a five-point scale of "often to rarely"

Population: Fifth and sixth grade teachers and their students in North Dakota

Reliability: Not available

Norms: Presented in dissertation by item

Validation: Several juries established content validity.

Reference: Semmons, Ronald L. "The Relationship of Elementary Science Classrooms to Selected Teacher and Student Variables." Unpublished doctoral dissertation, The University of North Dakota, 1970, p. 102.
University Microfilms Order No. 71-15,675

Title: SCIENCE TEACHING INFORMATION QUESTIONNAIRE

Factors: Organization of science program
Organization of instruction
Science teacher personal and biographical data

Format: Six pages of statements in multiple response format

Population: Sixth grade teachers

Reliability: Not available

Validation: Not available

Reference: Swan, Malcolm D. "An Exploratory Study of Science Achievement as it Relates to Science Curricula and Programs at the Sixth Grade Level in Montana Public Schools." Unpublished doctoral dissertation, University of Montana, 1965, pp. 201-207.
University Microfilms Order No. 65-12980

Title: BIOLOGY LABORATORY ACTIVITY CHECKLIST

Factors: Nature and extent of laboratory instruction in biology classes; 1) Pre-Laboratory activities, 2) Laboratory activities, 3) Post-Laboratory activities, and 4) General reaction to the laboratory

Format: 60 true-false items each referring to a laboratory practice. Students respond according to their perceptions of teacher use of that practice.

Population: Tenth grade biology students

Reliability: A _t_-test was computed for two classes of each of five teachers. In none of the five cases was the _t_ significant.

Norms: Group EB (Experienced BSCS Teachers) $\bar{X} = 39.25$
Group BB (Inexperienced BSCS Teachers) $\bar{X} = 33.46$
Group NB (Traditional Biology Teachers) $X = 28.87$
(Groups include one class for each of 21 teachers)

Validation: 1) Each item was based upon statements by individuals who participated in the development of the BSCS program.
2) Each item was verified by a panel of judges who were familiar with the BSCS program.

Reference: Barnes, Lehman W., Jr. "The Development of a Student Checklist to Determine Laboratory Practices in High School Biology." *Research and Curriculum Development in Science Education*, The University of Texas, Publication Number 6720, October 15, 1967, pp. 90-96.

Title: BIOLOGY ACTIVITY REPORT

Factors: Measures: 1) The relative number of decisions which had been made by students and teachers, 2) at which stages of problem solving decisions had been made by students, 3) the extent to which the laboratory activity was problem oriented, 4) the extent to which all students were working on the same problem and reaching the same conclusions.

Format: 44 yes-no items
20 five-option items

Population: Secondary school biology students in central Ohio

Reliability: Reliabilities (Spearman-Brown) for subscales range from .69 - .82
N = 290

Norms: See dissertation

Validation: Subscales established through factor analysis agreed with scales established conceptually

Reference: Best, Effie Deland. "An Exploratory Study of the Correlates of Student Decision Making in the Secondary School Biology Laboratory." Unpublished doctoral dissertation, The Ohio State University, 1970, p. 206.
University Microfilms Order No. 71-17,959

Title: CHECKLIST FOR ASSESSMENT OF SCIENCE TEACHERS (TWO VERSIONS; STUDENT AND SUPERVISOR PERCEPTIONS)

Factors: Assess teacher characteristics; 1) student-teacher relations, 2) classroom activities, 3) teacher's personal adjustment.

Format: 15 multiple-choice items - 5 for each factor. Student version does not include items bearing on the third factor

Population: Pre-service teachers in science education at The Ohio State University, their cooperating teachers, and their students and supervisors

Reliability: r = .74 (K-R 20)
N = 327

Validation: Expert opinion

Reference: Brown, William. "Teacher Competencies and Characteristics in a Science Pre-Service Teacher Education Project." Unpublished doctoral dissertation, The Ohio State University, 1972, p. 191.
University Microfilms Order No. 72-20,946

Title: KNOWLEDGE TEST OF THE PROCEDURE FOR SELECTED TEACHING SKILLS

Factors: Understanding of the correct sequence of steps used in nine different teaching procedures

Format: Respondent ranks steps within each of the procedures

Population: Student-teachers of secondary school science

Reliability: Not available

Validation: Face validity established by author

Reference: Currie, James Francis. "A Study of the Effects of a Teacher Aide Experience on the Preparation of Secondary School Science Student Teachers." Unpublished doctoral dissertation, The Pennsylvania State University, 1970, p. 132.
University Microfilms Order No. 70-24,151

Title: INSERVICE INSTITUTE QUESTIONNAIRE

Factors: Assess the impact of an inservice institute upon teachers' classroom practices

Format: 50 items

Population: Junior high school teachers

Reliability: Not available

Validation: Not available

Reference: See Appendix p. 311.

Title: QUESTIONNAIRE FOR PRINCIPAL, SUPERVISOR, CURRICULUM COORDINATOR, ETC.

Factors: Evaluation of impact of inservice institute upon teachers and teachers' classes

Format: Respondent asked to indicate relative agreement with each of 20 statements

Population: Junior high school administrators and supervisors

Reliability: Not available

Validation: Not available

Reference: See Appendix p. 309.

Title: SCIENCE CLASSROOM ACTIVITY CHECKLIST

Factors: Pupil's perceptions of the types of classroom activities being utilized by his teacher

Format: 41 true-false items

Population: 8th grade science students in Boulder, Colorado

Reliability: $r = .679$ (Hoyt)

Norms: $\overline{X} = 24.217$ to 26.433

Validation: A generalized modification of the Biology Classroom Activity Checklist developed by Kochendorfer and Lee. Five member jury established scoring on inductive vs. deductive criteria for each activity.

Reference: James, Helen Hope. "Effects of Three Supervisory Methods Upon the Development of a Teaching Strategy Among Science Student Teachers." Unpublished doctoral dissertation, University of Colorado, 1970, p. 176.

University Microfilms Order No. 70-23,724

Title: BIOLOGY CLASSROOM ACTIVITY CHECKLIST

Factors: The identification of actual classroom practices as they relate to the philosophy and rationale of the BSCS program; A - The role of the teacher in the classroom, B - Student classroom participation, C - Use of textbook and reference materials, D - Design and use of tests, E - Laboratory preparation, F - Type of laboratory activities, G - Laboratory follow-up activities.

Format: 53 true-false statements each referring to a classroom practice. Students respond according to whether they perceive the practice as being used by their teacher.

Population: Tenth grade biology students in eleven different states

Reliability: r = .96 using a procedure developed by Horst, P. "A Generalized Expression of the Reliability of Measures." *Psychometrics*, 14:21-32, 1949.

Norms: N = 1231 from 64 different classrooms

Group EB (Experienced BSCS Teachers) $\bar{X}$ = 65.70 S.D. = 8.14

Group BB (Inexperienced BSCS Teachers) $\bar{X}$ = 57.34 S.D. = 6.37

Group NB (Teachers not teaching BSCS) $\bar{X}$ = 50.04 S.D. = 5.90

Maximum score = 100 (% correct)

Validation: Items based on published statements of BSCS rationale. Five judges were asked to decide the degree to which each classroom practice contributed to BSCS objectives. There was a correlation of .84 among the judges decisions.

Reference: Kochendorfer, Leonard H. "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology." Research and Curriculum Development in Science Education, The University of Texas, Publication Number 6720, October 15, 1967, pp. 71-78.

Title: STUDENT-TEACHER PARTICIPATION CHECKLIST

Factors: The extent to which teachers use the classroom practices advocated by the developers of ESCP, IPS and ISCS.

Format: 36 items based upon classroom procedure; frequency of use indicated on a five-point response scale.

Population: Secondary school science students

Reliability: Not available

Validation: An adaptation of Kochendorfer's Biology Classroom Activities Checklist. Jury of six classroom teachers established content validity.

Reference: Myers, Mary Jayne. "A Study of the Identification of Classroom Practices of Teachers in the Use of Three New Junior High School Science Curricular Programs." Unpublished doctoral dissertation, University of Southern Mississippi, 1971, p. 54.
University Microfilms Order No. 72-9088

Title: PROCEDURAL BEHAVIOR INSTRUMENT: 1) STUDENT PERCEPTION 2) TEACHER PERCEPTION

Factors: Perception of teaching procedures used in classroom

Format: 30 items based on classroom procedures; frequency of use indicated on a five-point response scale.

Population: 10th grade biology students and their teachers

Reliability: r = .96 (Method not given)

Validation: Developed from Kochendorfer's Biology Classroom Activity Checklist. Validity coefficient = .84 (Method not given)

Reference: Pogirski, Alex Joseph. "A Correlation of Teacher Self-Assessment and Student Perception of the Instructional Behavior of High School Biology Teachers." Unpublished doctoral dissertation, The University of Michigan, 1971, p. 108 teacher form, p. 116 student form.
University Microfilms Order No. 72-14,965.

Title: VERBAL BEHAVIOR CHECKLIST: 1) STUDENT PERCEPTION 2) TEACHER PERCEPTION

Factors: Perception of verbal behaviors used in classroom

Format: 25 items based on classroom procedures; frequency of use indicated on a five-point response scale.

Population: 10th grade biology students and their teachers

Reliability: Not available

Validation: Not available

Reference: Pogirski, Alex Joseph. "A Correlation of Teacher Self-Assessment and Student Perception of the Instructional Behavior of High School Biology Teachers." Unpublished doctoral dissertation, The University of Michigan, 1971, p. 104 teacher form, p. 112 student form.
University Microfilms Order No. 72-14,965

Title: SCIENCE CLASSROOM ACTIVITY CHECKLIST: 1) TEACHER PERCEPTION 2) STUDENT PERCEPTION

Factors:
1) Nature of classroom activities which teachers feel should be used for secondary school science instruction.
2) Nature of activities which teachers do use as perceived by their students.

Format: 60 statements of activities with yes-no responses possible. (Based on instrument developed by Leonard Kochendorfer and Addison E. Lee, Research and Curriculum Development in Science Education, Science Education Center, The University of Texas at Austin, October, 1962.)

Population: Junior and senior high school science teachers in central Ohio

Reliability:
1) r = .841 (K-R 20)
2) r = .770 (K-R 20)

Validation: Authoritative validity established as a result of a 100% agreement in responses among four science educators and author to items on checklist when asked to respond in accordance with contemporary science education objectives.

Reference: Sagness, Richard L. "A Study of Selected Outcomes of a Science Pre-Service Teacher Education Project Emphasizing Early Involvement in Schools of Contrasting Environmental Settings." Unpublished doctoral dissertation, The Ohio State University, 1970, p. 189.
University Microfilms Order No. 71-7555

Title: STUDENT CHECKLIST

Factors: Degree of inductive-indirect or expository-direct strategy used in a laboratory teaching situation

Format: 42 items describing characteristic teaching activities. Respondents indicate by yes-no answer whether each is being carried on in their classroom. Two scores are obtained representing the two teaching strategies.

Population: Students in 7-12 grade science classes of the Boulder Valley Schools, Boulder, Colorado

Reliability: Expository-direct scale $r = .505$
Inductive-indirect scale $r = .669$
$N = 1446$
Using Hoyt ANOVA method (Hoyt, C. "Test Reliability Established by Analysis of Variance." Psychometrika 6:103-160, 1941)

Norms: Expository-direct $\bar{X} = 7.27$ S.D. = 1.89 20 items
Inductive-indirect $\bar{X} = 11.01$ S.D. = 1.80 22 items

Validation: Judges rated items with reference to the type of teaching strategy represented by the described activity.

Reference: Dr. Arthur L. White
Center for Science and Mathematics Education
The Ohio State University
1945 North High Street
Columbus, Ohio 43210

Title: STUDENT-TEACHING EVALUATION SCALE

Factors: Student perceptions of various aspects of student-teaching experience

Format: 13 Likert-type items

Population: Student teachers in secondary science at the University of Colorado

Validation: Face validity

Reference: James, Helen Hope. "Effects of Three Supervisory Methods Upon the Development of a Teaching Strategy Among Science Student Teachers." Unpublished doctoral dissertation, University of Colorado, 1970, p. 180.
University Microfilms Order No. 70-23,724

Title: SURVEY OF STUDENT PERCEPTION OF COURSE AND COLLEGE

Factors: Student perceptions of college environment (part I) and of instructor and general biology class (part II)

Format: Part I: 50 Likert-type items
Part II: 15 multiple-choice items

Population: General biology students in Jamestown Community College and in the State University of New York at Buffalo

Reliability: Not available

Validation: Items selected from: "Factored Scales for Measuring Characteristics of College Environments," Nunnally, et al. *Education and Psychology Measurement*, 23: 239-248, 1963, and The University of Minnesota, "Survey of Student Reactions to a Course and Instruction," 1961.

Reference: Kochersberger, Robert C. "A Comparison of Achievement of General Biology Students in a Community College with Similar Students in a University as Related to Their Backgrounds." Unpublished doctoral dissertation, State University of New York at Buffalo, 1965, p. 120.
University Microfilms Order No. 65-8896

Section 2: Knowledge and Attitudes About Classroom Practices and Curricula

Instrument Title Page

Elementary Science

[Bartlett Attitude Scale] 174
Elementary Science "Beliefs" 174
[Test of Knowledge of SAPA] 175
Attitude Survey 175
[Attitudes Toward Teaching Science] 176

Secondary Science

Study of Teacher Reactions to BSCS Program: Attitude Inventory 176
[Clark Attitude Scale] 177
[Issues in Science Education] 177
[Wonkka Attitude Scale] 178

College Biology

Attitude Toward Biolabs 178

Title: [BARTLETT ATTITUDE SCALE]

Factors: Feelings about 1) elementary science in general, 2) the Science Curriculum Improvement Studies (SCIS), materials in particular, 3) how the SCIS materials appear to children.

Format: Semantic differential format with three concepts and 36 bipolar adjective pairs

Population: Elementary school teachers

Reliability: Not available

Validation: Instrument given to two groups of teachers, one teaching SCIS and one not. Scales accurately predicted the differences between the two groups on the SCIS and Elementary Science scales.

Reference: Bartlett, Guilford Harrison, Jr. "Relation of a Small Group Variable to Implementation of an Innovation in Elementary Science." Unpublished doctoral dissertation, Columbia University, 1971, p. 127.
University Microfilms Order No. 72-4161

Title: ELEMENTARY SCIENCE "BELIEFS"

Factors: Beliefs about the nature of elementary school science, children and teaching

Format: 30 Likert-type items

Population: Prospective or in-service elementary school teachers

Reliability: Not available

Validation: Not available

Reference: Good, Ronald G. "A Study of the Effects of a "Student-Structured" Laboratory Approach to Elementary Science Education Methods Courses: Affective Domain." *Journal of Research in Science Teaching,* Vol. 8, No. 3:255-262, 1971.

Title: [TEST OF KNOWLEDGE OF SAPA]

Factors: Knowledge of program characteristics of AAAS *Science--A Process Approach* and Science Curriculum Improvement Study

Format: 57 multiple-choice items

Population: College teachers of elementary science and curriculum coordinators of science

Reliability: r = .6770 (K-R 20) N = 29

Norms: $\bar{X}$ = 34.89 S.D. = 5.55 S.E. = 3.08

Validation: Panel of science educators

Reference: See Appendix p. 269.

Title: ATTITUDE SURVEY

Factors: Respondent assesses the developmental potential of a particular academic or social skill through a given content area; arithmetic, language arts, reading, science, social studies.

Format: 75 questions with response indicated on a 7 point scale

Population: 1) Undergraduates in elementary education
2) Experienced teachers

Reliability: Two way analysis of variance reported on p. 53 of reference. Reliabilities with one exception are in excess of .70.

Validation: Construct validity established through use of expert opinion

Reference: Nelson, Paul A. "Attitudes Held by Elementary Education Teachers Toward the Developmental Potential of the Content Areas." Unpublished doctoral dissertation, University of Illinois, 1968, pp. 121-128.
University Microfilms Order No. 69-10, 807

Title: [ATTITUDES TOWARD TEACHING SCIENCE]

Factors: Attitudes toward teaching science in the elementary school

Format: Semantic differential form with seven concepts each accompanied by 20 bipolar adjective scales

Population: Pre-service teachers enrolled in an elementary science methods course at Michigan State University

Reliability: Internal consistency for each concept ranged from .87 to .95; overall .96
N = 240

Validation: Face validity

Reference: Staley, Frederick Allan. "A Comparison Study of the Effects of Pre-Service Teachers Presenting One or Two Microteaching Lessons to Different Sized Groups of Peers on Selected Teaching Behaviors and Attitudes in an Elementary Science Methods Course." Unpublished doctoral dissertation, Michigan State University, 1970, p. 206.
University Microfilms Order No. 71-11,980

Title: STUDY OF TEACHER REACTIONS TO BSCS PROGRAM: ATTITUDE INVENTORY

Factors: Teacher attitudes toward the BSCS Biology Program

Format: Respondent checks those statements he agrees with from a list of 46. Half of the statements reflect attitudes favorable to BSCS Biology and the remainder, traditional biology.

Population: Biology teachers enrolled in a summer institute

Reliability: Not available

Validation: Attitude inventory agreed with peer ratings and results of a follow-up questionnaire when each was used in classifying teachers' attitudes toward BSCS biology.

Reference: Blankenship, Jacob W. "The Development of an Attitude Inventory Designed to Determine Reactions of Biology Teachers to BSCS Biology." *Research and Curriculum Development in Science Education*. The University of Texas Publication, Number 6720, October 15, 1967, pp. 21-28.

Title: [CLARK ATTITUDE SCALE]

Factors: Personal attitudes of teachers (science and humanities) toward each other and toward each others' subject matter

Format: 28 Likert-type items

Population: Public high school teachers in Connecticut

Reliability: Not available
N = 118

Validation: Validation by jury

Reference: Clark, William Austin. "An Identification of the Gap Between the Scientific Culture and the Humanistic Culture in the Secondary School." Unpublished doctoral dissertation, The University of Connecticut, 1970, p. 81.
University Microfilms Order No. 71-15,969

Title: [ISSUES IN SCIENCE EDUCATION]

Factors: Attributes of individuals engaged in training science teachers

Format: 100 statements of major issues in science education; respondent is asked to indicate agreement or disagreement with each.

Population: Science teacher trainees at colleges and universities

Reliability: Not available

Validation: Not available

Reference: Weaver, Edward K. "Reactions of Science Educators to Certain Published Science Education Findings." Science Education, Vol. 47, No. 1:50-52, February, 1963.

Title: [WONKKA ATTITUDE SCALE]

Factors: Attitudes toward "new" science curricula

Format: Semantic differential using 25 concepts with 16 bipolar adjective pairs

Population: Teachers enrolled in inservice institute

Reliability: Not available

Validation: Literature search formed basis for selecting concepts

Reference: Wonkka, Richard Everett. "The Effects of Certain In-Service Institutes for Science Teachers on Their Attitudes Toward the "New" Science Curricula." Unpublished doctoral dissertation, University of Virginia, 1971, p. 123.
University Microfilms Order No. 72-7312

Title: ATTITUDE TOWARD BIOLABS:
1) STUDENT
2) INSTRUCTOR

Factors: Attitudes toward selected learning activities carried out by students in learning biology; including the use of materials, equipment and/or specimens.

Format: 15 Likert-type items on each instrument

Population: General biology students and instructors in junior colleges in Texas

Reliability: Student form r = .94 (alpha-coefficient)
Instructor form r = .83 (alpha-coefficient)
N = 29

Validation: Judges and factor analysis

Reference: Riggs, Julia Ree. "An Analysis of Student and Instructor Reactions to Biology and Selected Techniques of Biology Laboratory Instruction in Two-Year Colleges." Unpublished doctoral dissertation, The University of Texas at Austin, 1972, p. 91, 93.
University Microfilms Order No. 73-18,488

Section 3: Supervision and Evaluation of Instruction

Instrument Title Page

Supervisory Practices Instrument 180
Science Supervisory Style Instrument (Two versions: Teacher, Science Department Head) 180
Science Teacher/Science Department Head Questionnaire (two versions) 181
The Role of the Science Department Chairman of Baltimore County 181
Opinions on Self-Evaluation of Teaching Effectiveness 182
Science Supervisors Technical Skills Inventory 182

Title: SUPERVISORY PRACTICES INSTRUMENT

Factors: Supervisory practices of science supervisors

Format: Ten case studies of supervisory problems are presented with five possible solutions to each. Solutions are paired with each other. Best of each pair is selected. (paired comparison)

Population: Secondary school science supervisors

Reliability: Not available

Validation: Jury selected from membership of NSSA (23) and science educators (18)

Reference: Goode, John M. "The Development of an Instrument to Evaluate Certain Practices in Science Supervision." Unpublished doctoral dissertation, The Ohio State University, 1968, pp. 110-115.
University Microfilms Order No. 68-12840

Title: SCIENCE SUPERVISORY STYLE INSTRUMENT
(Two versions: Teacher, science department head)

Factors: Perception of supervisory style; nomothetic (emphasizing institutional expectations), ideographic (emphasizing individual expectations), and transactional (shifting emphases)

Format: 43 multiple-choice items divided into three subscales

Population: Department heads and science teachers from public schools of Massachusetts

Reliability: Subscales of Supervisor version $r = .269$ to $.829$ (K-R 20)
Subscales of Teacher version $r = .557$ to $.857$ (K-R 20)
$N = 21$

Reference: Peruzzi, William T. "Science Department Head Supervisory Styles and Their Affective Correlates." Unpublished doctoral dissertation, The Ohio State University, 1972, p. 378 and 406.
University Microfilms Order No. 73-2093

Title: SCIENCE TEACHER/SCIENCE DEPARTMENT HEAD QUESTIONNAIRE (two versions)

Factors: Job satisfaction, science teacher level of involvement, satisfaction with information flow, department head influence

Format: Part I: 28 items with 4 response choices indicating satisfaction. Part II: 31 items with 6 response scale indicating level of involvement

Population: Department heads and science teachers from public schools of Massachusetts

Reliability: r = .765 to .878 (Hoyt)
N = 18

Reference: Peruzzi, William T. "Science Department Head Supervisory Styles and Their Affective Correlates." Unpublished doctoral dissertation, The Ohio State University, 1972, p. 387.
University Microfilms Order No. 73-2093

Title: THE ROLE OF THE SCIENCE DEPARTMENT CHAIRMAN OF BALTIMORE COUNTY

Factors: Role of the Science Department Chairman

Format: A list of 21 duties; respondent asked to rank each on a five-point scale "As now performed" and again "As should be performed"

Population: Science teachers, secondary principals, science department chairmen and science supervisors in Baltimore County, Maryland

Reliability: Not available

Validation: Duties adapted from a report of the Committee on Supervisory Responsibilities, Board of Education of Baltimore County, Maryland, September, 1964.

Reference: Poscover, Benjamin Forrest. "The Perceptions of the Role of the Secondary School Science Department Chairman of Baltimore County, Maryland." Unpublished doctoral dissertation, University of Maryland, 1971, p. 119.
University Microfilms Order No. 71-25,255

Title: OPINIONS ON SELF-EVALUATION OF TEACHING EFFECTIVENESS

Factors: Attitudes of teachers toward self-evaluation

Format: 19 items using Likert-type response scale

Population: Upperclassmen enrolled in science teacher education at The Ohio State University

Validation: Factor analysis indicated construct validity

Reference: Smith, John Jay. "The Effect of an Instructional Sequence on Self-Evaluation Practices and Attitudes of Pre-Service Science Teachers." Unpublished doctoral dissertation, The Ohio State University, 1972, p. 164.

University Microfilms Order No. 73-2129

Title: SCIENCE SUPERVISORS TECHNICAL SKILLS INVENTORY

Factors: Technical skills in eight areas; leadership, curriculum development, inservice education, science facilities, equipment and materials, science teaching methods, self-growth, and public relations.

Format: Listing of 180 skills; respondent asked to assess his level of competence in each.

Population: Piloted by participants in AYI Supervisors Institutes at University of Maryland and The Ohio State University

Reliability: Not available

Norms: See page 158 of dissertation

Validation: Skills chosen based on ranking, made by nationally constituted jury of 183 individuals

Reference: Wheat, Lewin Albert. "An Identification of Technical Skills of Science Supervisors and the Development of a Science Supervisors Technical Skills Inventory." Unpublished doctoral dissertation, University of Maryland, 1970, p. 228.

University Microfilms Order No. 71-4531

Section 4: Course Content

Instrument Title | Page

Special Methods Course Questionnaire 184
[Environmental Management: Attitudes] 184
Checklist of Major Concepts in High School Biology 185
Sex Education Inventories 185
[High School Biology Inventories] 186

Title: SPECIAL METHODS COURSE QUESTIONNAIRE

Factors: Opinions concerning appropriate objectives for special methods courses in English, mathematics, science, and social studies

Format: 102 objectives with four possible responses; agree, disagree, restrict agree, no opinion

Population: College instructors of special methods courses, college supervisors of student teachers, supervising teachers of student teachers and secondary school administrators

Validation: Objectives selected through literature review and jury opinion

Reference: Bradley, Banks Thurston. "An Assessment of Objectives for Special Methods Courses for the Subject Areas of English, Mathematics, Science, and Social Studies." Unpublished doctoral dissertation, Indiana University, 1970, p. 254.
University Microfilms Order No. 71-11,367

Title: [ENVIRONMENTAL MANAGEMENT: ATTITUDES]

Factors: Respondents' attitudes toward selected environmental management concepts and towards the respondent's adequacy in teaching the concepts

Format: 67 concepts each having two response scales with 2 seven-point ranges; Importance (not important--important), Your Capability (inadequate--adequate)

Population: Teachers of first, third and fifth grades in the Ames (Iowa) Public Schools

Reliability: r = .94 to .97 (Cronbach-alpha)

Validation: Concepts selected from concept list compiled by Robert A. Roth, Environmental Management Concepts--A List. Technical Report 126. Wisconsin R & D Center for Cognitive Learning, Madison, April, 1970.

Reference: Hulleman, Harold Wayne. "Effects of In-Service Training on Elementary Teachers Pertaining to Science Achievement and Attitudes Toward Environmental Science." Unpublished doctoral dissertation Iowa State University, 1972, p. 132.
University Microfilms Order No. 73-3896

Title: CHECKLIST OF MAJOR CONCEPTS IN HIGH SCHOOL BIOLOGY

Factors: Emphasis given major biological concepts in biology curricula

Format: 9 major concepts each with 7-11 subconcepts listed; respondent indicates the degree to which each is emphasized on a five-point scale.

Population: Secondary school biology teachers

Reliability: Not available

Validation: Face validity based on concepts identified by the Biological Sciences Curriculum Study

Reference: Knotts, Carl Rudolph. "Biological Education and the Structure of Knowledge Concept in Selected High Schools." Auburn University, 1971, p. 170.
University Microfilms Order No. 72-682

Title: SEX EDUCATION INVENTORIES
1. Student Interests
2. Student Needs
3. High School Seniors
4. Professionals
5. Parents

Factors: Opinions of various groups as to needs in sex education

Format: 117 concepts each allowing a yes-no response. The same concepts appear on all forms.

Population: Ninth and twelfth grade students, teachers, principals, counselors, clergy, physicians, and parents from Monroe County, Indiana

Reliability: Not available

Validation: Content identified through analysis of teaching materials. Items validated by jury of local and national experts.

Reference: Lowing, Lawrence Francis. "Expressed Needs and Interests as a Basis of Sex Education for Ninth Grade Students." Unpublished doctoral dissertation, Indiana University, 1971, p. 259.
University Microfilms Order No. 72-16,679

Title: [HIGH SCHOOL BIOLOGY INVENTORIES]
1. Interest Inventory
2. Need Inventory

Factors: Interests in and needs for biology concepts associated with health

Format: Each inventory has the same 62 items with five-point scale to indicate degree of interest in one case and need in the other.

Population: Students in inner-city high schools of Buffalo, New York

Reliability: Interest Inventory r = .94
Need Inventory r = .88

Validation: Analysis of textbooks and syllabi and the judgement of competent persons established curricular validity

Reference: Metcalf, Zubie West. "An Analysis of Interests and Needs in Biology Concepts Associated with Health." Unpublished doctoral dissertation, State University of New York at Buffalo, 1972, p. 95.
University Microfilms Order No. 72-18,636

Section 5: Teacher Expectations of Students

Instrument Title	Page
Expectations Inventory	188

Title: EXPECTATIONS INVENTORY

Factors: Teacher expectation of students

Format: Respondents asked to indicate proportion of their students that could do each of 24 activities. Instrument assesses the degree to which class can function in an open learning environment.

Population: Teachers of junior high school science students

Reliability: Not available

Validation: Not available

Reference: See Appendix p. 315.

Section 6: Facilities

Instrument Title	Page
Facilities Checklist	190

Title: FACILITIES CHECKLIST

Factors: Nature of facilities used for science instruction; room design, fixed laboratory facilities, laboratory equipment, laboratory assistants, budget considerations, and field trips

Format: A number of specific items are listed under each of the seven topics. Respondent indicates degree to which each is available.

Population: Secondary school science teachers

Reliability: Not available

Reference: Brewington, William Cleve. "A Study of First Year Secondary School Science Teachers Who Completed Preservice Programs at The Ohio State University." Unpublished doctoral dissertation, The Ohio State University, 1971, p. 228.

University Microfilms Order No. 72-4433

APPENDIX

EVALUATION INSTRUMENTS

The instruments included in this appendix were identified as a result of a survey of members of the National Association of Research in Science Teaching conducted in 1970 and 1971. They are not readily available from the sources identified in the introduction to the Handbook (page 1). Therefore they have been included here with the permission of the author. The 1974 address of the author is included on the title page of each instrument. The author should be contacted directly for permission to use his instrument.

MATHEMATICS SKILL TEST FOR CHEMISTRY

Dr. Rita T. Denny
University of Pennsylvania
37th and Walnut Streets
Philadelphia, Pennsylvania 19174

Reference: Denny, Rita T. "The Mathematics Skill Test (MAST) in Chemistry." Journal of Chemistry Education, Vol. 48, No. 12:845-846, December, 1971.

1. Express 4520 as a number times a power of 10.

   a) 4.52×10^2

   b) $.452 \times 10^3$

   c) 4.52×10^3

   d) $.452 \times 10^2$

   e) 4.52×10^4

2. $2\left(\frac{3}{4}\right) + 3\left(\frac{4}{12}\right) =$

   a) $1\frac{1}{2}$

   b) $2\frac{1}{3}$

   c) $2\frac{1}{2}$

   d) 6

   e) $6\frac{1}{12}$

3. $2(2 + 3 - 1) =$

   a) 4

   b) 6

   c) 8

   d) 10

   e) 12

4. If 5 yards of material cost $2.50, how much will 2 feet cost?

   a)$.34

   b)$.67

   c)$1.00

   d)$1.50

   e)$1.75

5. $2\left[3(2Y)\right] =$

   a) 7Y

   b) 8Y

   c) 10Y

   d) 12Y

   e) some other amount

6. A car goes 3 miles an hour. How many feet will it go in 30 minutes?

   a) 2740 ft.

   b) 3520 ft.

   c) 5280 ft.

   d) 7920 ft.

   e) some other amount

7. $-53°C. + 273°C. =$

   a) 326°C.

   b) 230°C.

   c) 226°C.

   d) 220°C.

   e) some other amount

8. If you earn $4552 a year and must pay 12% of this in federal income tax and 3% in wage tax, what is your net income after these taxes have been paid?

   a)$3859.20

   b)$3869.20

   c)$3985.20

   d)$4005.76

   e)$4483.72

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9. If 2 apples cost 20 cents, how much will 7 apples cost?

a)$.35

b)$.70

c)$1.00

d)$1.40

e)some other amount

10. $-\log_{10} 10^{-4} =$

a) -40

b) 40

c) 10

d) -4

e) 4

11. If .045 is subtracted from 24.6 the result is

a) 23.15

b) 24.15

c) 24.55

d) 24.555

e) 24.655

12. The decimal equivalent of $\frac{4}{50} + \frac{2}{25}$ is

a) $\frac{8}{50}$

b) .08

c) .016

d) 16

e) 1.6

13. Which is the largest quantity?

a) 10^2

b) 10^1

c) 10^0

d) 10^{-1}

e) 10^{-2}

14. $3(12 - 15) - 5 =$

a) -14

b) -8

c) -2

d) 4

e) 16

15. If $\frac{12\,c^2}{c^3} = 1$, $C =$

a) 0

b) 1/12

c) 1

d) 12

e) 144

16. In 2000 lb. of coal ore, 79% is pure coal. You have sufficient oxygen available to burn 50% of the coal ore. How many lb. of pure coal is available from the remaining unburned ore?

a) 1000 lb.

b) 990 lb.

c) 800 lb.

d) 790 lb.

e) 700 lb.

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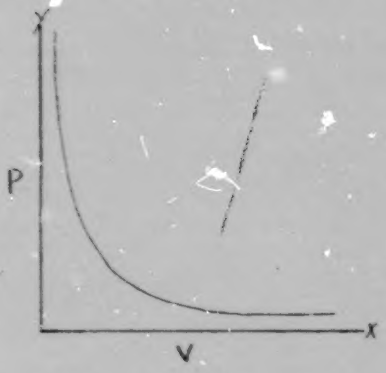

17. In the graph at the left, as the volume (V) increases, the pressure (P)

a) increases

b) decreases

c) remains the same

18. In the graph at the left, as the pressure (P) increases, the volume (V)

a) increases

b) decreases

c) remains the same

---

19. If PV = k is the equation for a line and k = 4, which of the following pairs of values satisfies this relationship?

a) (1,4)

b) (X,1)

c) (1,X)

d) (1,-X)

e) (-1,X)

20. $\frac{4 \times 10^{-2}}{2 \times 10^{-3}} =$

a) 2×10^{-5}

b) 2×10^{-1}

c) 2×10^{1}

d) 2×10^{5}

e) some other number

21. 3.25 ÷ .25 =

a) .013

b) .13

c) 1.3

d) 13

e) some other amount

Question 22 refers to the formula below in which G is a constant.

$$F = G \frac{m_1 m_2}{r^2}$$

22. If the values of r and m_2 remain constant and the value of m_1 doubles, F is

a) multiplied by 4

b) multiplied by 2

c) divided by 2

d) divided by 4

e) not changed

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23. $\frac{4^3}{4^8}$ =

a) 1^{-5}
b) 4^{-5}
c) 1^5
d) 4^5
e) 4^{11}

24. $7.5\overline{)\ .375}$ =

a) .005
b) .05
c) .5
d) 5
e) 50

25. If 2 apples cost 20 cents the largest number of apples I can buy with 50 cents is

a) 1
b) 2
c) 3
d) 4
e) 5

26. 2280 ÷ 760 =

a) 5
b) 4
c) 3
d) 2
e) some other number

27. $\frac{625}{25}$ =

a) 20
b) 24
c) 25
d) 30
e) 35

28. $\dfrac{\frac{320}{1.6}}{\frac{4.8}{.8}}$ =

a) $\frac{1}{3}$
b) $3\frac{1}{3}$
c) $33\frac{1}{3}$
d) $333\frac{1}{3}$
e) some other amount

29. $\frac{(.2)(.03)}{.1} \times \frac{5(2.2)}{11}$ =

a) .006
b) .012
c) .06
d) .12
e) .6

30. -25°K. minus 173°K. equals

a) -198°K.
b) -178°K.
c) -158°K.
d) 148°K.
e) 158°K.

31. If 100,000 square feet are multiplied by 4 the result is

a) 4×10^6 sq. ft.
b) 4×10^5 sq. ft.
c) 4×10^4 sq. ft.
d) 4×10^3 sq. ft.
e) 4×10^2 sq. ft.

32. $9^{1/2}$ =

a) 3
b) 6
c) 9
d) 81
e) some other amount

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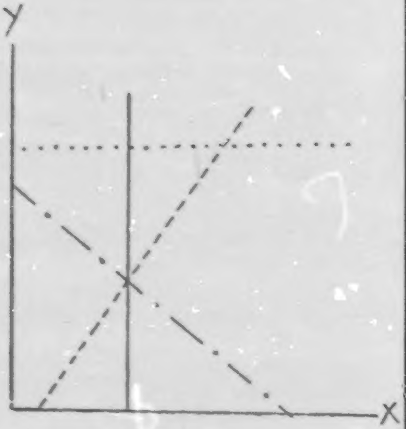
33. In the graph at the right which graphed line segment has a negative slope?

a) - - - - -
b) —·—·
c) ·······
d) ———
e) none of these

34. In the graph at the right which graphed line segment has a slope equal to zero?

a) - - - - -
b) —·—·
c) ······
d) ———
e) none of these



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35. In a chemical reaction $\frac{4}{5}$ of 32 lbs. of sulfur is consumed. The percentage of sulfur remaining is

a) 20%
b) 25%
c) 50%
d) 75%
e) 80%

36. 25 x .30 =

a) .750
b) 7.50
c) 75.0
d) 750
e) some other amount

37. With a 6% sales tax, how much tax would you have to pay on $10.00?

a) $6.00
b) $.60
c) $.06
d) $.12
e) $1.20

38. .052 + 37.5 =

a) 42.7
b) 38.12
c) 38.02
d) 37.02
e) some other amount

39. $\frac{\frac{3}{4}}{\frac{4}{9}} =$

a) 27/16
b) 7/4
c) 3/4
d) 1/2
e) 1/3

40. $3^2 =$

a) 3 x 3
b) 3 + 3
c) 3 x 2
d) 3 ÷ 2
e) some other amount

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41. $3(12)(36) \div 6(72) =$

a) 3

b) 4

c) 6

d) 12

e) some other amount

42. If $3X + 5 = 2X + 8$, $X =$

a) $\frac{13}{5}$

b) $\frac{3}{5}$

c) 3

d) 13

e) some other number

43. In a 100 lb. mixture of sand and rock, there is twice as much sand as rock. How many lb. of sand are there?

a) 25 lb.

b) $33\frac{1}{3}$ lb.

c) 50 lb.

d) $66\frac{2}{3}$ lb.

e) some other amount

44. $3^{-2} =$

a) $-(3 \times 2)$

b) $-(3 \times 3)$

c) $3^{1/2}$

d) $\frac{1}{3 \times 3}$

e) $\frac{1}{3 \times 2}$

45. $(3^2)^3 =$

a) 3×3

b) $(3 \times 2)(3 \times 2)$

c) $(3 \times 2)(3 \times 2)(3 \times 2)$

d) $3 \times 3 \times 3 \times 3 \times 3$

e) $3 \times 3 \times 3 \times 3 \times 3 \times 3$

46. $-2575 + 45321 =$

a) 42746

b) 42756

c) 42846

d) 42856

e) 43746

47. If $\frac{X}{20} = \frac{4}{5}$, $X =$

a) 16

b) 20

c) 25

d) 30

e) some other amount

48. Which one of the quantities below is larger than $\sqrt{256}$?

a) 256^2

b) 1/256

c) $256^{-1/2}$

d) $256^{1/2}$

e) $256^{1/4}$

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Plot the following data, with "concentration" measured on the y-axis and "time" indicated on the x-axis. Sketch a line through the points you have plotted.

Concentration	Time
2 g	1 sec
4 g	2 sec
6 g	3 sec
8 g	4 sec

49. From the graph, the concentration at 1.5 sec is

a) 1 g
b) 1.5 g
c) 2 g
d) 2.5 g
e) 3 g

50. The time for a concentration of 5 g is

a) 1.5 sec
b) 2 sec
c) 2.5 sec
d) 3 sec
e) 3.5 sec

51. In 5 sec the concentration would probably be

a) 7 g
b) 8 g
c) 9 g
d) 10 g
e) 11 g

---

52. In a screw cap bottle, you have 2 ounces of tincture of Iodine, a weight mixture of 98% alcohol and 2% dissolved Iodine. By accident you spill half the mixture. How much alcohol do you have left?

a) .098 oz.
b) .98 oz.
c) 1 oz.
d) 1.96 oz.
e) some other amount

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53. The decimal equivalent of $2(10^2)(10^{-3})$ is

a) 2

b).2

c).02

d).002

e)some other number

54. $\dfrac{7.2 \times 10^{-3}}{.6 \times 10^4} =$

a) 1.2×10^1

b) 1.2×10^{-7}

c) 12×10^1

d) 12×10^{-7}

e) some other number

55. $5280 \times 12 =$

a) 6336

b) 63260

c) 63460

d) 64360

e) some other number

56. Express .72 as a number times a power of 10

a) 7.2×10^2

b) 7.2×10^1

c) 7.2×10^0

d) 7.2×10^{-1}

e) 7.2×10^{-2}

57. $10^0 =$

a) 1

b) 0

c) 100

d) 10

e) some other amount

58. 10^{-1} expressed as both a fraction and as a decimal is

a) $\frac{1}{100}$ and .1

b) $\frac{1}{100}$ and .01

c) $\frac{1}{10}$ and .001

d) $\frac{1}{10}$ and .01

e) $\frac{1}{10}$ and .1

59. If the \$5.60 you have in your wallet is 25% of your wages, how much did you earn?

a)\$10.20

b)\$14.00

c)\$21.40

d)\$27.40

e) some other amount

60. $2 \times 10^{-2} =$

a) .02

b) .2

c) 2

d) 20

e) 200

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A TEST OF ABILITY TO IDENTIFY AND APPLY SELECTED PRINCIPLES OF PHYSICS

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GENERAL DIRECTIONS. On the answer sheet print your last name, first initial, and middle initial in the place provided. You need **NOT** code your name. Indicate your sex, by blackening the appropriate space in the lower half of the right side of the answer sheet.

Turn the answer sheet so the space indicating sex is at the top. Note the spaces provided for the answers are in three parts and are numbered **ACROSS** the page.

Below are four questions which should be answered in the part labeled REQUIRED INFORMATION. In each item select the option that best describes your science background and blacken the proper space on the answer sheet.

Upon completing these four items, go immediately to Part I and begin the test.

REQUIRED INFORMATION.

1. Mark one of the following.
   a) I have taken a high school physics course.
   b) I am presently taking a high school physics course.
   c) I have not taken nor am I presently taking a high school physics course.

2. Since grade seven, how many science courses have you taken included, as of the program, the study of some of the principles of physics?
   a) 1.
   b) 2.
   c) 3.
   d) 4.
   e) 5.

3. How many years has it been since completing the last science course that included some of the principles of physics in its program?
   a) 0, (I am now taking such a course.)
   b) 1 year, (I took such a course last year.)
   c) 2 years.
   d) 3 years.
   e) 4 years.

4. If you have had or are taking a course in high school physics, was it
   a) the Physical Science Study Committee (P.S.S.C.) Course?
   b) a traditional physics course with a standard text and laboratory exercises?
   c) a blend of the two programs stated in (a) and (b) above?

USE PENCIL ONLY. DO NOT USE A PEN.

ERASE COMPLETELY ANY ANSWER YOU MAY WISH TO CHANGE.

BE SURE THE MARK IS BLACK AND COMPLETELY FILLS THE SPACE.

PART I.

DIRECTIONS. In each of the questions below there is a true principle of physics given. Under the PRINCIPLE an event or phenomenon, called the SITUATION, is described. Apply the principle to the given situation and select the answer which represents the application of the principle. Beware! There may be many true statements among the options, but only one results from the application of the principle to the specific situation. Time is not a factor. When you finish Part I go on to Part II immediately.

EXAMPLE.

Principle: Heat is transferred by convection, in currents of gases or liquids, the rate of transfer decreasing with increases in the viscosity of the circulating fluid.

Situation: Farmers often place large tubs of water in a fruit cellar

a) to keep the fruit moist.
b) to keep the air moist
c) to prevent rot.
d) to prevent freezing.

In this example, (d) represents the proper application of the stated principle.

---

1. **Principle:** If the same pressure is maintained, the volume of a given mass of gas varies directly as the absolute temperature.

Situation: Gasoline is sometimes stored in covered cylindrical tanks which must have a small opening at the top in order to keep pressures from building up inside. Despite the hole this type of storage creates problems because

a) the build up of pressure could explode the tank.
b) liquid gasoline could leak out on a hot day.
c) rain leaks into the gasoline, thereby diluting it.
* d) gasoline vapors escape on hot days and air is pulled in at night mixing with the gasoline vapors.

2. **Principle:** Pieces of iron, steel, cobalt, or nickel may become magnetized by induction when placed within a magnetic field.

Situation: In "orienting a map", a tenderfoot spread a small map on the ground held down from the wind by his knife and ax. He then used his compass to line up the map toward the north. This camper

* a) will actually line the map in a false direction.
b) will be all right if he corrects for the difference between true north and magnetic north.
c) must also consider the angle of inclination of the magnetic field.
d) will be all right as he has made no error.

3. **Principle:** Electrons will always flow from one point to another along a conductor if this transfer releases energy.

   Situation: Very often on the roadways in front of the collector's booth on a toll bridge you will see three or four strands of metal stripping projecting out of the pavement like the leaves of a daffodil. As the car moves over the metal leaves, they brush against the chassis of the car. This arrangement is used because

   a) fires often occur in car engines on the bridge.
   ★ b) the men in the toll booth complained about getting an electric shock every time they reached for the coins.
   c) mud and other material often dropped off on the bridge and produced a higher ground.
   d) it serves to prevent lighting from being attracted to the car while it is on the bridge.

4. **Principle:** If a beam of light falls upon an irregular surface, the rays of light are scattered in all directions.

   Situation: If rough places develop on the cornea of a man's eye, images formed and seen by him will

   a) lack color.
   ★ b) be blurred.
   c) have black spots.
   d) have the wrong shape.

5. **Principle:** When a sounding body is moving toward or away from an observer the apparent pitch will be higher or lower, respectively, than the true pitch of the sound emitted.

   Situation: Two cars are moving in the same direction at 50 miles per hour. One driver blows his horn, the other driver will hear the pitch of that horn

   a) higher than if both cars were at rest.
   b) lower than if both cars were at rest.
   ★ c) the same as if both cars were at rest.
   d) lower than if his car were at rest, but the other was moving away.

6. **Principle:** Electric power (measured in watts) is directly proportional to the product of the potential difference (measured in volts) and the current (measured in amps).

   Situation: In a typical home the voltage is usually rated at 120 volts. A bulb using power at a rate of 40 watts would use

   a) 40 amp.
   b) ¼ amp.
   c) 30 amp.
   ★ d) ⅓ amp.

7. **Principle:** The force of gravitational attraction between two masses varies directly as the product of the masses and inversely as the square of the distance between the centers of the two masses.
Situation: If astronomers were to discover a planet whose radius was three times the earth's radius, but whose mass was equal to that of the earth, a man on the new planet would weigh
a) ⅓ as much as he did on earth.
b) 3 times as much as he did on earth.
★ c) 1/9 as much as he did on earth.
d) 9 times as much as he did on earth.

8. **Principle:** Electrons in an atom change energy levels by emitting or absorbing energy.
Situation: If a luminous-dial watch was observed in a darkened room with a magnifying glass, one would notice
★ a) the light was produced by many small flashes.
b) some small areas never light up.
c) the light emitted to be a continuous glow.
d) some heat was given off.

9. **Principle:** The mass of an atom is concentrated almost entirely in the nucleus, therefore, the volume of the atom consists mostly of emptiness.
Situation: A scientist once designed an experiment in which alpha particles (helium nuclei) were to bombard a thin sheet of gold. The result was
a) all the alpha particles bounced back.
b) most bounced back, some got through.
c) all the alphas passed through the foil.
★ d) most passed through, occasionally one bounced.

10. **Principle:** The pressure in a fluid in the open is greater than atmospheric pressure by an amount equal to the weight of the fluid above a unit area divided by that area; it, therefore, varies as the depth and average density of the fluid.
Situation: Engineers in constructing and designing large water tanks must, in calculating the necessary thickness of the walls, consider
a) the area of the bottom of the tank.
b) how high above the ground will the tank be.
★ c) the depth of the water when the tank is full.
d) the height above sea level.

11. **Principle:** A body immeresed or floating in a fluid is buoyed up by a force equal to the weight of the fluid displaced.
Situation: A steamship moves down the river into the more dense ocean. As it does the ship on the ocean will
★ a) float at a higher level than in the river.
b) float at the same level as in the river.
c) float at a deeper level than in the river.
d) float at various levels depending on the tide.

12. **Principle:** When two vectors act upon the same point, the resultant is the diagonal of a parallelogram whose sides represent the direction and magnitude of the two forces.

Situation: A boy, sitting in a railroad car moving at a certain velocity throws a ball straight up into the air. The ball will fall

a) behind him.
* b) back to him.
c) in front of him.
d) with the downward velocity equal to the speed of the train.

13. **Principle:** Energy can be changed from one form to another, or to matter with exact equivalence.

Situation: If a brick is raised to a height and dropped, it gains kinetic energy until it hits the ground

a) the energy is then completely annihilated.
b) the energy will cause the brick to bounce up to its former height.
c) matter will be created as the brick breaks into pieces.
* d) most of the energy will be changed to heat.

14. **Principle:** The acceleration experienced by a body is directly proportional to the net force and inversely proportional to the mass.

Situation: A man decided to climb a rope which was set through a pulley. He attached to the other end of the rope a mass equal to his own so it would hold the rope when he pulled himself up. To his surprise

a) the mass was lifted off the ground as he pulled the rope and he did not get off the ground.
* b) both he and mass came off the ground and stayed even as he climbed, but it took him twice as long to climb to the top than if he had tied down the other end.
c) the mass stayed still as he climbed the rope.
d) both he and the mass came off the ground, but the mass went up twice as fast as he.

15. **Principle:** When one body exerts a force on a second body, the second body exerts an equal and opposite force on the first.

Situation: Every helicopter has a small propeller on its tail whirling in a vertical plane. Without this little propeller the helicopter would

a) not get off the ground.
b) fly in circles.
* c) spin in the direction opposite to that of main rotor.
d) fly upside down.

16. **Principle:** The color of the various objects depends upon what light they transmit, absorb, or/and reflect.
Situation: As one observes a rose, it appears to be red because

a) it refracts the red light.
★b) it reflects the red light.
c) it absorbs the red light.
d) it transmits the red light.

17. **Principle:** When two vectors act upon the same point, the resultant is the diagonal of a parallelogram whose sides represent the direction and magnitude of the two vectors. A single force represented by the diagonal may be resolved into two vectors represented by the sides of the parallelogram.

Situation: Pilots often argue that a fast airplane will drift less than a slow plane of the same weight and design when a wind acts at right angles on both for a given length of time. The statement is

a) true because the resultant of the forward motion of the plane and the force of the wind is greater in the case of the fast plane.
b) false because there is an equal and opposite reaction to every action.
c) false because the drift is independent of and unaffected by the forward motion.
★d) True because a pilot can fly between two cities in the faster plane with less correction for drift than in the slow plane.

18. **Principle:** The darker the color of a surface, the better it absorbs light.

Situation: Any object which is totally black is observed to to be black because

a) black surfaces reflect no light.
b) no light is absorbed by black surfaces.
★ c) most light is absorbed by black surfaces.
d) refraction occurs on black surfaces.

19. **Principle:** When the resultant of all the forces acting on a body is zero the body will stay at rest if at rest, or it will keep in uniform motion in a straight line if it is in motion.

Situation: Assuming no air resistance and no friction, imagine a car is moving along a straight road at a constant speed. The sum of the forces acting on the car will be

★ a) zero, or continuously zero.
b) continuously a constant amount, not zero.
c) zero, then a constant amount greater than zero, then zero again.
d) continuously changing in amount.

PART II.

DIRECTIONS: In this part of the test, an event or phenomenon, called the SITUATION, is described. Select the principle of physics which is the major cause or explanation for the situation, from the possible options. Note that each of the options is a true principle of physics, but only one is the chief cause or explanation for the situation.

EXAMPLE.

Situation: Fisherman note that ponds and streams of clear water often appear to be more shallow than they really are. This phenomenon occurs because

a) waves of light travel in straight lines while passing through a homogeneous or uniform mediun.
b) when light rays pass obiquely from a dense to a rarer medium, they are bent away from the normal.
c) if a beam of light falls upon an irregular surface, the rays of light are scattered in all directions.
d) the darker the color of a surface the better it absorbs light.

In this example, (b) represents the principle that best explains the situation.

---

1. **Situation:** A high altitude weather balloon is never fully inflated when it is launched, thus insuring its reaching a high altitude.

* a) the atmospheric pressure decreases as the altitude increases.
b) the atmospheric pressure decreases with increasing water vapor.
c) in the northern hemisphere great volumes of air resolve in a counter-clockwise direction.
d) in moving air, wind pressure increases as the square of the velocity.

2. **Situation:** Many years ago, when homes lacked central heating, bricks and metal blocks were heated, wrapped in towels, and placed at the foot of the bed to keep warm. The rubber hot water bottle proved to be a great improvement because

a)most bodies expand on heating and contract on cooling; the amount of change depending upon the change in temperature.
b) heat is conducted by the transfer of kinetic energy from molecule to molecule.
c) the lower the temperature of a body, the less the amount of energy it radiates; the higher the temperature, the the greater is the amount of energy radiated.
* d) most materials heat up and cool off more rapidly and more readily than water does.

3. **Situation:** It sometimes happens in a football game that when two players collide - a faster moving small player with a slow moving larger player - it is the larger slow moving player that gets knocked down. The principle used here by the small man is
   * a) the amount of momentum possessed by an object is proportional to its mass and its velocity.
   b) when the resultant of all the forces acting on a body is zero, the body will stay at rest if at rest, or will keep in uniform motion in a straight line if it is in motion.
   c) the speed gained by a body with constant acceleration is equal to the product of the accleration and the time.
   d) the energy which a body possesses because of its motion is called kinetic energy and is proportional to the radius of rotation.

4. **Situation:** Many people have noticed that dirty snow melts quicker than clean snow. This happens because
   a) bodies of land heat up and cool off more rapidly and more easily than bodies of water.
   b) heat is liberated when a gas is compressed and is absorbed when a gas expands.
   * c) dark, rough, or unpolished surfaces absorb or radiate energy more effectively than light, smooth, or polished surfaces.
   d) most bodies expand on heating and contract on cooling; the amount of change depending upon the change in temperature.

5. **Situation:** The Carnegie Institute has for many years used an almost entirely wooden ship to make magnetic surveys. The advantage gained is due to the fact that
   a) magnets depend for their properties upon the arrangement of the metallic ions of which they are made.
   * b) pieces of iron, steel, cobalt, or nickel may become magnetized by induction when placed within a magnetic field.
   c) like magnetic poles always repel each other.
   d) an electric charge in motion produces a magnetic field about the conductor, its direction being tangential to any circle drawn about the conductor in a plane perpendicular to it.

6. **Situation:** People who have been paralyzed by the effects of polio are often exercised in tanks of warm water. This is done because
   a) diffusible substances tend to scatter from the point of greatest concentration until all points are at equal concentration.
   b) the pressure at a point in any fluid is the same in all directions.
   * c) a body immersed or floating in a fluid is buoyed up by a force equal to the weight of the fluid displaced.
   d) most bodies expand on heating and contract on cooling.

7. **Situation:** If you like to take showers you have probably been annoyed at one time or another by the tendency of a shower curtain to move toward you with persistent regularity. The main reason for this is

   a) the average speed of molecules increases with the temperature and pressure.
   b) a change in state of a substance from gas to liquid, liquid to solid, or vice versa, is usually accompanied by a change in volume.
   * c) as the velocity of flow through a constricted area increases, the pressure diminishes.
   d) heat is liberated when a gas is compressed and is absorbed when a gas expands.

8. **Situation:** In the middle 1950's an experiment was performed in which a proton was given a great speed in an accelerator. It was then caused to collide with another proton. After the collision scientists detected four protons, the two original ones plus two new ones. This is an example of

   a) radioactive emission involves nuclear changes.
   b) all matter is made up of protons, neutrons, and electrons.
   c) atoms have great subatomic energy.
   * d) matter may be transformed into energy and energy into matter; the sum total, matter plus energy, remains constant.

9. **Situation:** Recently radioactive elements are being used as tracers to find out how such things as how food is used and stored by the human body. this is possible because

   * a) radioactivity is independent of all physical conditions, heat, cold, pressure, and chemical state.
   b) matter may be transformed into energy and energy into matter; the sum total, matter plus energy, remains constant.
   c) all matter is made up of protons, neutrons, and electrons.
   d) radioactive emission involves nuclear changes.

10. **Situation:** A man confined in a closed room decides to use an electric fan to cool the room. To his dismay, because energy was added to a confined gas, the temperature of the room increases This was predictable because

   a) heat is liberated when a gas is compressed.
   b) if the volume of a confined body of gas is kept constant, the pressure is proportional to the absolute temperature.
   * c) all materials offer some resistance to the flow of electric current and that part of the electrical energy used in overcoming this resistance is transformed into heat energy.
   d) a gas always tends to expend throughout the whole space available.

11. **Situation:** A housewife decided to grow plants in her kitchen using sand and chemicals. Two flower pots were filled with sand, one a white beach sand and the other a dark volcanic sand. Both sands were non-nutrients to the plants and the same amount of chemicals and water were added to each. To the surprise of the housewife, the dark volcanic sand always produced the first bud above the the sand. This conclusion is predictable because

   a) bodies of land heat up and cool off more rapidly and more readily than bodies of water.
   b) the lower the temperature of a body, the less the amount of energy it radiates; the higher the temperature, the greater is the amount of energy radiated.
   * c) dark, rough, or unpolished surfaces absorb or radiate energy more effectively than light, smooth, or polished surfaces.
   d) radiant energy travels in waves along straight lines, its intensity at any distance from the point source is inversely proportional to the square of the distance from the source.

12. **Situation:** Several boys, using empty oil drums, decided to build a raft. Upon completion of the raft they found that it set too low in the water. One boy suggested that they seal the drums and remove all the air. He said this would cause the raft to float higher in the water. They agreed to try and see what would happen. To their surprise, **NO NOTICEABLE** change in the floating level resulted. This result was predictable because

   a) the pressure at a point in any fluid is the same in all directions.
   * b) a body immersed or floating in a fluid is buoyed up by a force equal to the weight of the fluid displaced.
   c) any homogeneous body of liquid free to take its own position in which all exposed surfaces will be on the same horizontal plane.
   d) when forces act in the same direction, the resultant is their algebraic sum.

13. **Situation:** It is known that on the moon, man will not be able to converse in the usual manner. However, it has been suggested that if astronauts put their space helmets together as they talk, hearing will be possible because

   a) the speed of sound increases with an increase in temperature of the medium conducting it.
   b) the loudness of a sound depends upon the energy of the sound wave and if propagated in all directions, decreases inversely as the square of the distance from the source.
   c) energy is often transmitted in the form of waves.
   * d) sound is produced by vibrating matter and is transmitted by matter.

14. **Situation:** A boy goes sailing in a boat at the lake. Just as he gets to the middle of the lake the wind dies and the sails go slack. The thought occurs to him that if he had brought a large fan to mount on the boat to blow wind perpendicularly in the sails he could sail home. Unfortunately the scheme will fail because

a) energy can be changed from one form to another, or to mater, with exact equivalance.

* b) when one body exerts a force on a second body, the second body excerts an equal and opposite force on the first.

c) a gas always tends to expend throughout the whole space available.

d) in moving air, wind pressure increases as the square of the velocity.

15. **Situation:** A student noticed that after quickly scribbling on a pad of paper with a pencil, the pages of the pad of paper would stick together. The result occurs because

* a) an electric charge and an electric current can be produced by chemical action, by friction, by use of magnets and by induction.

b) electrons have both a magnetic and an electric field.

c) a magnet always has poles and is surrounded by a field of forces.

d) changes on a conductor tend to stay on the surface and to be greatest on the sharp edges and points.

16. **Situation:** If a baseball pitcher throws a knuckleball (no spin) such that it leaves the hand parallel with the ground, it can be observed that the ball will always be closer to the ground as it crosses the plate. The reason for this can be explained by the fact that

a) energy can be changed from one from to another, or to matter,with exact equivalance.

* b) at any point on the earth's surface all bodies fall with a constant acceleration which is independent of the mass, size or vertical direction of motion, if air resistance be neglected.

c) the energy which a body posses on account of its position form is potential energy and is measured by the work that was done in order to bring it into the specified condition.

d) a spinning body offers resistance to any force which changes the direction of the axis about which the body rotates.

17. **Situation:** Small boys for years always delighted in using a mirror to shine sunlight into the teacher's eyes. These same small boys are invariably caught because the teacher would know

* a) light travels in straight lines in a medium of uniform optical density.

b) the intensity of illumination decreases as the square of the distance from a point source.

c) if a beam of light falls upon an irregular surface, the rays of light are scattered in all directions.

* d) when light is reflected the angle of incidence is equal to the angle of reflection.

ERIE SCIENCE PROCESS TEST

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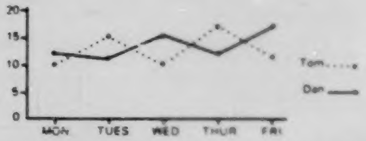
Science Processes

1 In basketball practice, two boys shot 20 shots each day for five days. Here are the results in terms of baskets made:



On which day did Tom make the most baskets?

1 Monday
2 Tuesday
3 Wednesday
* 4 Thursday
5 Friday

2 A science teacher asked five of her students to take four measurements (in centimeters) each of a plant that had been growing for eight days. Here are the results:

Measurement	1	2	3	4
Rusty	3	3	2	1
Mike	2	3	2	2
Jeff	3	2	4	5
Karen	4	3	7	2
Steve	4	2	6	3

Whose measurements were the most precise? That is, whose measurements were the most consistent?

1 Rusty
*2 Mike
3 Jeff
4 Karen
5 Steve

3 Mary wants to make a diagram of the school gymnasium on a piece of notebook paper. A convenient scale for her to use would be

1 1 centimeter = 1 decimeter
* 2 1 centimeter = 1 meter
3 1 meter = 1 kilometer
4 1 kilometer = 1 decimeter
5 1 decimeter = 1 kilometer

4 A tennis ball was dropped from several different heights, and the height the ball bounced was recorded each time. Which of the following would be the *best* method to report the data collected?

1 A written paragraph
2 A tally of the number of bounces
3 A frequency distribution
* 4 A bar graph
5 A pie chart

5 Which of these statements best represents a hypothesis?

1 This magnet picked up twelve paper clips.
2 The milk in this bottle froze in twenty minutes.
* 3 If a liquid is heated, it will expand.
4 The leaves on that maple tree have all turned red.
5 At this rate, the pool will fill in ten minutes.

6 Which of the following is an operational definition?

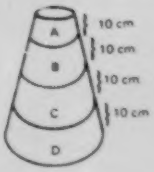
* 1 Sweet – the taste you experience when you eat sugar
2 Inch – a unit of linear measurement
3 Flower – a group of specialized leaves
4 Rectangle – a type of four-sided geometrical figure
5 None of the above

7 In most experiments some variables must be held constant. Which variable listed below must be held constant if you want to find out which of two pieces of cloth absorbs water faster?

1 The kind of cloth
2 The color of the cloth
3 The time of day
4 The height that the water rises in each cloth
* 5 The length of time the cloths are in water

Science Processes

8 Examine the diagram below of a jar filled with water.



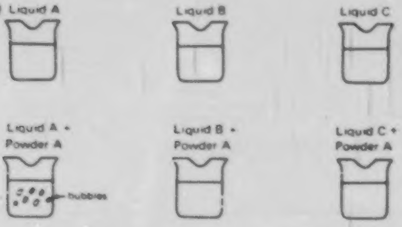
The volume of water —

1 **is greatest in section A**
2 **is greatest in section B**
3 **is greatest in section C**
* 4 **is greatest in section D**
5 **is the same in each section**

9 A tire company wants to know if they will get as much mileage from a new type of tire as from their usual tire. Which one of the following variables would it be *most* important to control in an experiment?

1 **The time of day the test is made**
* 2 **The number of miles traveled by each type of tire**
3 **The physical condition of the driver**
4 **The weather conditions**
5 **The weight of the car used**

10



Which inference is best supported by the above observations?

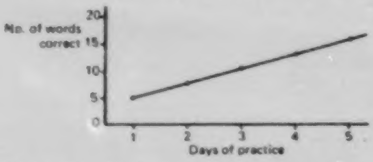
1 **Liquids A and C are the same.**
* 2 **Liquids A and B are not the same.**
3 **Liquids B and C are not the same.**
4 **Liquids A, B, and C are all the same.**
5 **None of the above answers is correct.**

11 A large bowl contains 50 marbles. Thirty of these are black, 5 are blue, and 15 are red. If a blindfolded person selects one marble from the bowl, what are his chances that it will be a red one?

1 5 50
2 20 50
3 30 50
* 4 15 50
5 25 50

12 *Hypothesis:* Increased practice increases learning of spelling words.

The chart shows Sally's improvement in spelling.



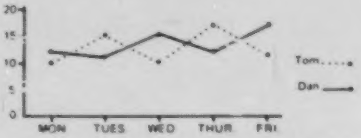
The data in this chart —

1 **prove the hypothesis**
2 **disprove the hypothesis**
* 3 **support the hypothesis**
4 **do not support the hypothesis**
5 **have no meaning as far as the hypothesis is concerned**

13 The influence of two new drugs on a student's ability to learn is to be tested. Which of the variables listed below would be *most* important to control in the experiments?

* 1 **The amount of each drug taken**
2 **The time of day the drugs are given**
3 **The shape of the drug pills**
4 **The location of the experiment**
5 **The color of the drugs**

14 In basketball practice two boys shot 20 foul shots each day for five days. Here are the results in terms of baskets made:

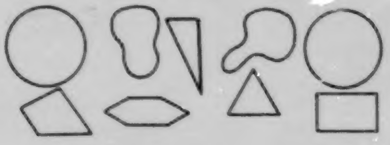


On which day did Dan make the most baskets?

1 **Monday**
2 **Tuesday**
3 **Wednesday**
4 **Thursday**
* 5 **Friday**

Science Processes

15 Which would be the best characteristic to use in classifying the following objects?



1 Square vs. not a square
2 Four edges vs. not four edges
3 Circle vs. triangle
* 4 Curved edge vs. straight side
5 Odd number of sides vs. even number of sides

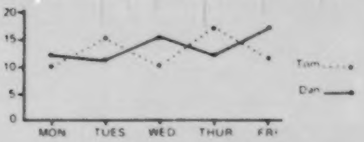
16 A science teacher had five of her students take four measurements each of the height of a plant that had been growing for eight days. Here are the results (in centimeters).

Measurement	1	2	3	4
Rusty	3	3	2	1
Mike	2	3	2	2
Jeff	3	2	4	5
Karen	4	3	7	2
Steve	4	2	6	3

What is the average (the arithmetic mean) of Karen's four measurements?

1 5 cm.
* 2 4 cm.
3 3 cm.
4 2 cm.
5 1 cm.

17 In basketball practice, Dan and Tom each shoot twenty foul shots each day for five days. Here are the results in terms of baskets made:



On how many days did Tom make more baskets than Dan?

1 1
* 2 2
3 3
4 4
5 5

18 What is the sum of 3 and −5?

1 8
2 0
3 2
* 4 −2
5 −8

19 Which of these definitions is stated operationally?

1 Paper clip: a bent metal device for holding paper together
2 Carbon dioxide: a colorless, odorless, tasteless gas which is found in air
* 3 Asymmetrical: when cut in half and the halves are folded together along the cut, the halves do not match
4 Meter: a unit of linear measurement in the metric system
5 Leaf: a part of a plant

20 In an experiment to determine which color of construction paper becomes warmest in sunlight, which one of the variables below is *least* important to hold constant?

* 1 The time of day the experiment is carried out
2 The kind or type of paper used
3 The length of time the paper is in the sunlight
4 The thermometer used to measure each piece of paper
5 The size of the pieces of paper used

21 A group of students conducted an experiment to determine the effect of heating (roasting) on the germination of sunflower seeds. Which of the variables listed below is *least* important to control in this experiment?

1 The degree to which the seeds are heated
2 The length of time the seeds are heated
3 The type of soil used
4 The amount of moisture in the germinating chambers
* 5 The size of container used

Science Processes

22 A book publisher prints two editions of the same arithmetic textbook. One is printed in red ink, one in green ink. One hundred students are divided at random into two groups of 50. One group is taught by Teacher A with the red-ink text; one group is taught by Teacher B with the green-ink text. All classes are held in the afternoon. In this experiment, the variable which was not held constant was —

1 **the size of the group of students**
2 **the topics in arithmetic taught to each group**
3 **the content of the textbooks**
★ 4 **the color of the ink in the textbooks**
5 **the time of day of the classes**

23 Which of these statements represents the best operational definition?

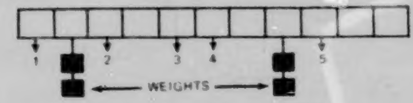
1 **Leaf: a part of a plant**
★ 2 **Weight: the property of an object that can be measured by hanging the object on the end of a spring and observing the degree to which the spring is pulled down**
3 **Bug: an electronic device used in wiretapping**
4 **Shell: a solid object composed of calcium carbonate**
5 **Bird: one of five classes of animals with inside skeletons which belong to a larger goup called vertebrates**

24 Bill placed one ice cube in a jar. The ice cube melted in 20 minutes. Two ice cubes placed in the same jar melted in 50 minutes. Without trying it, Bill said it would take over 60 minutes for three ice cubes to melt in the same jar.

Bill's statement is an example of —

1 **an observation**
★ 2 **a prediction**
3 **a classification**
4 **an experiment**
5 **a measurement**

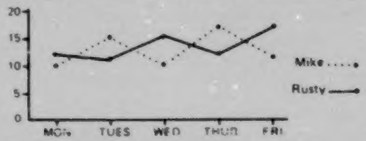
25 Examine the following sketch.



At what point would the bar be balanced?

1 5
2 1
3 4
★ 4 3
5 2

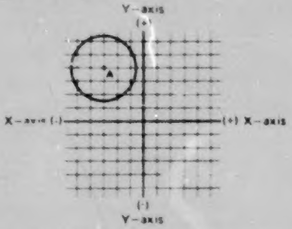
26 Rusty shoots foul shots left-handed; Mike shoots right-handed. In basketball practice, each boy shot twenty foul shots each day for five days. Here are the results in terms of baskets made:



Given these data one can infer that —

1 **left-handed foul shooters are more accurate than right-handed**
2 **right-handed foul shooters are more accurate than left-handed**
★ 3 **Rusty is a more consistent foul shooter than Mike**
4 **Rusty has had more experience at foul-shooting than Mike**
5 **all of these statements are correct**

27 Examine the following grid.



The coordinates for Point A (at the center of the circle) are represented by which of the following pairs of numbers?

★ 1 **-3 and 4**
2 **3 and -4**
3 **3 and 4**
4 **-3 and -4**
5 **-7 and 7**

28 Which of the following operational definitions is most complete?

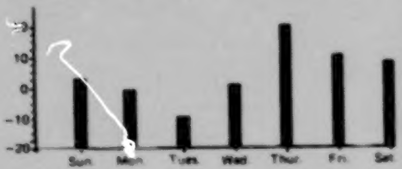
1 **Inch: a unit of measure**
2 **Rain: more than two liters of water falling from the sky**
3 **Rock: a solid, hard, brittle object formed in nature**
4 **Animal: a living organism which can move, reproduce, grow, and respond to stimuli**
★ 5 **Calorie: the amount of heat needed to raise the temperature of one gram of water 1° Centigrade**

Science Processes

29 What shape of shadow could a cylinder not form?

1 A circle
2 A square
3 A rectangle
* 4 A triangle
5 All of the above

30 The highest daily temperature recorded each day for a week is shown on this graph.



Which of the following statements is correct?

1 Monday had the coolest temperature.
* 2 The warmest temperature was recorded on Thursday.
3 It snowed all day on Friday.
4 On Wednesday it was warmer than on Sunday.
5 Saturday was the warmest day of the week.

31 Eight bean seeds were germinated, then divided into four groups of two seeds each. One group of two seeds was grown under red light, another under yellow light, another under blue light, and the fourth under ordinary white light. At the end of two weeks the growth of each group of plants was measured to see which group of plants had grown the most.

This experiment could best be improved by —

1 giving more water to the plants grown under red light
* 2 increasing the number of seeds grown in each of the four groups
3 growing the plants under white light in sandy soil but all others in loamy soil
4 measuring the growth of the plants each day
5 growing plants also under purple light

32 Which of the following is *not* an operational definition?

1 Rowing: to propel a boat with oars along the surface of the water
2 Ice: a translucent solid which you can change into a liquid by warming it to a temperature of 0° C.
3 Starved: the state of your body if you do not eat for three days
* 4 Oxygen: a colorless, odorless, tasteless gas common in the earth's atmosphere
5 Symmetrical: when cut in half, and the halves are folded together along the cut, the halves match

33 During the night Steve had been awakened by a violent thunderstorm. Walking to school the next morning, he saw a large tree blocking the street. At school, Steve told his teacher that a big tree had been knocked down by the storm last night.

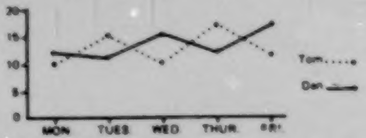
Steve's statement to his teacher was —

1 an observation
2 a prediction
* 3 an inference
4 a hypothesis
5 a measurement

34 Which of the following definitions is stated operationally?

* 1 Calorie: the amount of heat needed to raise the temperature of one gram of water 1° Centigrade
2 Kilogram: unit of mass in the metric system
3 Flower: a part of a plant
4 Bottle: a container
5 No correct answer is given.

35 In basketball practice two boys shot twenty foul shots each day for five days. Here are the results in terms of baskets made:



On how many days did Dan make more baskets than Tom?

1 2
2 1
3 5
4 4
* 5 3

COGNITIVE PREFERENCE TEST: HIGH SCHOOL CHEMISTRY

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Reference: Marks, Ronald L. "CBA High School Chemistry and Concept Formation." Journal of Chemical Education, Vol. 44: 471-474, August, 1967.

Cognitive Preference Test
HIGH SCHOOL CHEMISTRY

DIRECTIONS

In this test you are to indicate which one of four choices you prefer. Each test item begins with an introductory statement or diagram. This information is followed by four lettered choices. Each of these choices is **correct.**

Read the introductory statement and all four choices carefully. Select the choice you prefer most in connection with the introductory information. Then blacken the corresponding space on your answer sheet. Remember, all the information given is factually correct. You should choose the answer that **has most appeal or is most satisfying to you** because of the chemistry course you had.

You may find that more than one choice for each test item appeals to you. However, select only **one** choice for each item. **Be sure to** answer every question, even though the decisions may be difficult to make.

Sample item

1. It is a very hot muggy afternoon in July.
   - A. Baseball games are being played.
   - B. Some people are swimming.
   - C. The temperature and relative humidity are high.
   - D. Movies are playing in air-conditioned theaters.

All four lettered choices are correct. You are to choose the **one** choice that appeals to you most. Thus, for example, a baseball fan might choose A, whereas a good swimmer might choose B.

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1. A compound which forms a basic solution in water is calcium oxide.
 ★ (A) Oxides of active metals are basic anhydrides.
 (B) The process is used by a plasterer in slaking quicklime.
 (C) The statement suggests that when CaO is placed in acidic solution, neutralization could occur.
 (D) The type of bonding in the compound could be explained by its reaction with water.

2. A chemical change produces a new substance with new chemical properties.
 (A) The new substance formed must be of lower chemical potential with respect to the original substance.
 (B) The chemical and physical properties of the newly formed substance are different from those of the original substance.
 (C) Rust does not have the same properties as pure iron.
 ★(D) To study change is to study chemistry.

3. Carbon dioxide is soluble in water.
 ★(A) Bubbles rise in a newly opened bottle of soda water.
 (B) Carbon dioxide is more soluble in water at high pressure and low temperature.
 (C) An equilibrium is established between the gaseous solute and its solvent.
 (D) The solubility of gases in liquid is directly proportional to the pressure of the gas above the liquid.

4. The volume of a given mass of gas is inversely proportional to the pressure exerted on it.
 (A) This is Boyle's law.
 ★ (B) The statement implies a lower limit to volume.
 (C) The principle is related to the fact the helium balloons are not completely filled before they are released.
 (D) The statement is incomplete since the temperature must be taken into account also.

5. According to the Arrhenius theory, when an acid and a base react, the products formed are water and a salt.
 ★ (A) This is known as neutralization.
 (B) The statement could read: "When hydronium and hydroxide ions unite—."
 (C) Not all bases release the hydroxide ion in a water solution.
 (D) The principle explains the relief obtained from an upset stomach when soda water is taken.

6. In the electrolysis of sodium chloride, the product at the anode is chlorine.
 (A) Chlorine may be prepared commercially by electrolysis.
 ★ (B) For chlorine to be formed at the anode, the chloride ion has to lose one electron per ion.
 (C) Commercially, this reaction is carried out in a Hooker or Vorce cell.
 (D) The anode is always the electrode where oxidation occurs.

7. A sample of water, containing no solid particles, is boiled and then filtered. The compound left on the filter paper is calcium carbonate.
 (A) The sample is known as temporary hard water.
 (B) No mention is made of the fact that before boiling the compound was in the form of $Ca(HCO_3)_2$
 (C) $Ca(HCO_3)_2$ is thermally unstable.
 ★ (D) A similar principle is involved in the formation of stalactites and stalagmites.

8. A salt which dissolves in water and forms a basic solution is sodium carbonate.
 (A) The statement implies that the carbonate ion is capable of donating an electron pair to some species.
 ★ (B) The carbonate ion increases the hydroxyl ion concentration in aqueous solution by forming carbonic acid.
 (C) The solution should change red litmus paper blue.
 (D) This is a commercial preparation for bicarbonate of soda (baking soda).

9. When an organic carboxylic acid and an alcohol react, the products are water and an ester.
 (A) Many perfumes are made from esters.
 (B) The (OH) group from the acid is found in the water product.
 (C) The reaction can be catalyzed by a strong acid.
 ★ (D) This process is called esterification.

10. The volume of oxygen gas that can be liberated from the decomposition of 18 grams of water is 11.2 liters.
 ★ (A) The actual volume will depend on the temperature and pressure at which it is collected.
 (B) The cost for producing oxygen in this manner is rather high.
 (C) One-half a mole of any gas occupies a volume equal to one-half the molar volume at the same temperature and pressure.
 (D) A molar volume of hydrogen would be produced in the same reaction.

Items 11 and 12 apply to the following section of the periodic chart.

	I	II	III	IV	V	VI	VII	VIII
2	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr

11. C, N, and O are members of the second period.
 (A) Each successive member of the series contains one more proton than the preceding one.
 (B) N has a higher ionization potential than either C and O because N has three half-filled p orbitals.
 (C) Atomic size would decrease from C through O.
 ★ (D) Each of these elements is found in proteins.

12. O, S and Se are members of group VI.
   (A) With an increase in atomic mass, the odor of the hydrogen compounds of these elements becomes more obnoxious.
 * (B) Atomic size would increase from O through Se.
   (C) Se would be the least reactive of the elements indicated.
   (D) Se has underlying *d* electrons that the other members do not have.

13. The equilibrium vapor pressure of a given liquid and the atmospheric pressure are equal.
 * (A) The temperature at which this occurs is called the boiling point of the liquid.
   (B) To the advantage of the housewife, these conditions can be changed in a pressure cooker.
   (C) To achieve these conditions, van der Waals forces and/or dipole-dipole forces of the liquid are involved.
   (D) Vapor pressure is characteristic to the liquid and the atmospheric pressure to altitude.

14. A particular compound is always composed of the same elements in the same ratio by mass.
   (A) Pure table salt bought in this country would be chemically the same as that in any other country.
   (B) The stoichiometry of a compound depends upon the bonding capabilities of the elements involved.
   (C) This statement is known as the Law of Definite Composition.
 * (D) The above statement does not apply precisely when isotopes are involved.

15. Some substances can affect a chemical reaction without themselves being consumed in the reaction.
   (A) The substances mentioned above are known as catalysts.
   (B) All catalysts are directly involved in the reaction although they are not permanently altered.
 *(C) Ptyalin is a substance which affects the rate of digestion of starch.
   (D) Catalysts affect the rates of chemical reactions by lowering or raising activation energies.

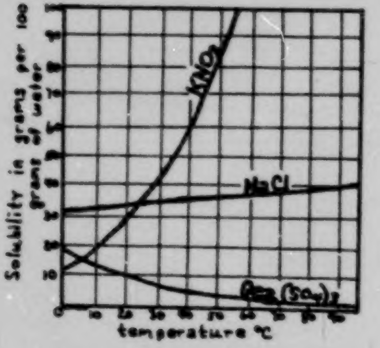
16. The electron-dot formula of an uncombined carbon atom is $\cdot\dot{\underset{\cdot}{C}}\cdot$.
   (A) The dot formula does not consider that the $2s^2$ electrons are paired.
   (B) Only electrons outside the kernel are shown in the dot formula.
 * (C) Electrons which are located in lower energy levels than the outermost electrons are usually not involved in chemical bonding.
   (D) The electrons symbolized above are responsible for the properties of diamonds.

17. When silver nitrate is added to a solution of sodium chloride, insoluble silver chloride is formed.
   (A) "Insolubility" is a relative term more precisely defined by using solubility product constants.
   (B) Silver nitrate solution must be handled carefully because it will leave a black spot on skin.
 * (C) This process of ion separation is called precipitation.
   (D) When compounds of high lattice energies are formed in solution, they usually separate as solids.

18. The ionization potential for hydrogen is 13 electron volts (e.v.), or 300 kcal per mole.
   (A) 13 e.v. is the energy required to remove the electron from the hydrogen atom.
 * (B) The energy of forces on neighboring atoms must be considered.
   (C) The energy that must be supplied to the atom to remove an electron is inversely related to atomic radius.
   (D) The ionization potential of hydrogen elucidates, at least in part, the chemical properties of hydrogen.

19. Thiosulfate ($S_2O_3{}^{2-}$) is a divalent ion.
 * (A) The salt, sodium thiosulfate, is commonly called hypo and is used as a fixer in photography.
   (B) The oxidation state of sulfur in thiosulfate ion is +2.
   (C) The thiosulfate ion, or any ion, is an atom or group of atoms with an unbalanced electrostatic charge.
   (D) Because there is only a small difference (1.0) in the electronegativities of sulfur and oxygen, covalent bonding could be expected between them.

Items 20 and 21 apply to the following graph of solubilities.



20. (A) The above graph suggests the infinite solubility of KNO_3 at 100° C.
 * (B) Although a general rule, the above data suggest that not all salts increase in solubility with an increase in temperature.
   (C) If 40 grams of NaCl were dissolved in 100 grams of water at 50°C, the solution would be supersaturated.
   (D) It is a "waste of fuel" to raise the temperature of soup in order to dissolve table salt.

21.*(A) The solubility of NaCl changes very little with a rise in temperature.

(B) There will be a dynamic equilibrium between the dissolved K^+ and NO_3^- ions and KNO_3 solid

(C) The data presented in the graph suggest that the hydration energy of $Ce_2(SO_4)_3$ is greater than its lattice energy.

(D) A chemist could use similar graphs when determining the quantity of chemicals to order for his experiments.

22. In the presence of finely divided platinum, hydrogen is easily oxidized to water. No outside source of energy is necessary to start the reaction.

(A) This principle could be applied to igniting an oxygen-hydrogen torch.

★ (B) The above statement suggests that the bond between the two hydrogen atoms is considerably weakened when in contact with the platinum.

(C) This phenomenon is related to adsorption.

(D) Finely divided platinum is able to adsorb considerable quantities of hydrogen. As a result, hydrogen is more reactive than ordinary hydrogen.

23. Oxidation may be defined as the loss of electrons.

(A) The statement, as given above, fails to consider the presence also of an oxidizing agent.

*(B) The principle is basic to the rusting of automobile fenders.

(C) The substance which is oxidized is the reducing agent.

(D) The principle is basic for understanding oxidation reactions.

24. Gas molecules are essentially independent particles.

*(A) The statement is less true at low temperatures and high pressure.

(B) In a vacuum distillation the temperature of vaporization would be lower.

(C) The statement is in accordance with the Kinetic Molecular Theory.

(D) This principle allows gases to be compressed into small tanks for delivery and use.

25. Water may be heated, vaporized and condensed into a separate container.

(A) The energy of vaporizing the water is conserved when the gas condenses.

(B) The statement does not consider the possibility of vacuum distillation where temperature would not be a great factor.

(C) The principle can be used to render sea water drinkable.

*(D) The principle is known as distillation.

26. The formula mass of sucrose is approximately 342.

(A) One pound of table sugar would constitute nearly 1 1/3 mole weights of sucrose

(B) 342 grams of sucrose would represent one mole.

(C) A mole of any compound would be composed of 6.02×10^{23} molecules.

(D) The number of molecules in a mole of any substance is independent of the mass of each molecule.

27. The freezing point of a one molal water solution of NaCl is approximately —3.48 C. The theoretical value would be — 1.86 C x 2 = —3.72 C.

(A) The principle is called Raoult's Law.

(B) The lowering of the freezing point of a pure solvent is proportional to the number of solute particles present.

★ (C) The principle explains in part why ice melts when salt is put on it.

(D) The data suggest that there is some interionic attraction between the ions in solution.

28. An acid is a substance which releases H^+ into a water solution.

(A) This theory is named after Arrhenius.

(B) Vinegar is an acid.

(C) The statement limits the solvent to water.

★ (D) The more general a definition of an acid or base can be made, the more phenomena can be included in the theory.

29. If a system at equilibrium is subjected to a stress, the equilibrium will be displaced in such a direction to relieve the stress.

(A) This is a fundamental law of chemistry that applies to all dynamic equilibria.

★ (B) The statement is known as La Chatelier's Principle.

(C) One wonders if the statement is true when several different stresses are applied simultaneously to a system.

(D) In the synthesis of ammonia from N_2 and H_2 (Haber process), the reaction is carried out at high pressure and low temperature.

30. When the fission of an uranium 235 nucleus takes place, one set of products is Kr^{95} and Mo^{139} and two to three neutrons.

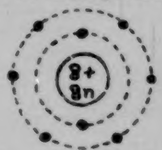
*(A) It is striking to note that the products are not equal in mass.

(B) Such fission reactions can be used peacefully in the production of electricity.

(C) The above reaction can be controlled in a nuclear reactor.

(D) If the neutrons produced are "slowed down", they in turn can cause the fission of another nuclide.

Item 31 applies to the following structure of an atom:



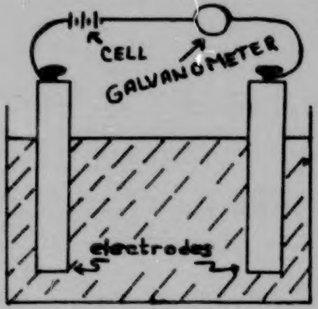
(A) Based on present theory, the radius of an atom is not exactly a constant as could be assumed from the drawing.

(B) The K shell contains two electrons while the M shell can hold a maximum of eight.

*(C) Structural models, such as the one above, are often convenient to explain chemical phenomena.

(D) The above structure fails to consider ionization energies of electrons.

Items 32 and 33 apply to the following electrolytic cell.



32. Suppose the solution in the container was NaCl.
    - (A) The electrolyte (NaCl solution) would conduct the current, completing the circuit.
    - (B) Such a cell could be used to produce NaOH as a by product of the electrolysis.
    - (C) Hydrogen is discharged at one electrode rather than sodium because it has a lower electrode potential than sodium.
    - ★ (D) When the circuit is complete, chlorine and hydrogen gases are produced. The remaining solution will remain electrically neutral, however, with the production of sodium ions and hydroxyl ions.

33. Suppose the solution in the container was NaCl. The products at the electrodes would be Cl_2 and H_2 gases.
    - (A) A similar cell is used commercially to produce Cl_2.
    - ★ (B) The Cl_2 would be given off at the anode.
    - (C) Water molecules would receive electrons at the cathode (reduction) and chloride ions would give electrons.
    - (D) A quantitative statement of the energy changes involved could be made if electrode potentials were given.

34. The volume of a gas is directly proportional to temperature, provided pressure remains constant:
    - ★ (A) The statement applies only to a given mass of gas.
    - (B) The statement is Charles' Law.
    - (C) The statement implies a lower limit to temperature.
    - (D) The principles are related to the observation that overheated bicycles tires "blow out".

35. When a block of dry ice (—78°C) is exposed for observation, it is apparent that it does not melt, but rather, it vaporizes.
    - (A) The forces between CO_2 molecules in dry ice must be weak.
    - ★ (B) The statement suggests that dry ice could be used as a refrigerant.
    - (C) This phenomenon is called sublimation.
    - (D) When the atmospheric pressure is equal to the vapor pressure of a solid, the solid sublimes.

36. For the reaction $A + 2B \rightleftarrows C$, the equilibrium expression is

$$K = \frac{[C]}{[A]\,[B]^2}.$$

    - (A) The numerical value of K is a constant for only one temperature.
    - (B) The constant is called the equilibrium constant.
    - ★ (C) The reverse reaction can be written as the reciprocal of the forward reaction.
    - (D) The statement suggests that the numerical value of the constant will give a qualitative indication of the "direction" of the predominating reaction at equilibrium.

37. The formula $CuSO_4 \cdot 5H_2O$ symbolizes the compound copper sulfate.
    - ★ (A) The compound is a hydrate.
    - (B) The compound is used to kill algae in ponds.
    - (C) The formula suggests that the hydration energy of the compound is less than its anhydrous form.
    - (D) The water molecules in the salt are chemically bonded in the crystal.

38. The addition of a salt with an ion common to the solution of a weak electrolyte reduces the dissociation of the electrolyte.
    - (A) This principle is known as the common ion effect
    - (B) The statement can be related to maintaining the pH of human blood at 7.3.
    - ★ (C) The statement, as given above, assumes a dynamic equilibrium to exist between the dissociated and undissociated species.
    - (D) When the above statement is applied to slightly soluble salts, solubility of the ionic salt is generally decreased by the added common ion.

39. The solubility of gases in liquids is directly proportional to the pressure of the gas above the liquid.
    - ★ (A) A bottle of soft drink fizzes when it is opened.
    - (B) The degree of solubility of the gas is temperature dependent.
    - (C) This is Henry's Law.
    - (D) The gas which dissolves in the liquid is the same gas which determines the pressure above the liquid.

40. One mole of methyl alcohol is dissolved in enough water to make one liter of solution.
    - ★ (A) Such a solution will have a lower freezing point than that of the pure water solvent.
    - (B) The solution is known as a molar solution.
    - (C) The solution could be used as an anti-freeze.
    - (D) The lowering of the freezing point of water by the methyl alcohol is proportional to the number of particles added.

41. One gram equivalent of calcium hydroxide is dissolved in water to make a liter of solution.
    - (A) Since the gram equivalent is a basic combining unit, the statement suggests a stoichiometry between reacting volumes of similarly prepared solutions.
    - ★ (B) Such a solution is known as a normal solution of calcium ions.
    - (C) The solution involves the availability of 2 moles of electrons for a chemical reaction.
    - (D) On a larger scale, similar calcium hyroxide solutions are used in the tanning industry.

42. The degree of dissociation of an electrolyte depends upon the nature of the solvent.
(A) The polarity of water "pulls" the electrolyte apart.
(B) In solvents other than water the behavior of solutes may be different.
(C) HCl dissolved in benzene is a non-conductor of electricity.
*(D) For a quantitative relationship of dissociation of a solute, bonding energies within the molecule must be considered.

43. Distilled water has a pH of 7.
*(A) This water could be used to prepare medical solutions.
(B) The hydrogen ion concentration in the water is 10^{-7} moles per liter.
(C) In pure water, all H^+ and OH^- must come from the dissociation of water molecules.
(D) In any water solution no matter what the pH, there will be both H^+ and OH^- present.

44. Ice is a hexagonal structure of water molecules.
(A) Because of this ice floats on water.
(B) Ice is less dense than water.
(C) Ice has a definite geometry because of three dimensional hydrogen bonding among H_2O molecules.
*(D) A hydrogen atom between two oxygen atoms in the ice lattice is electrostatically bonded to both.

45. The formula for barium peroxide is BaO_2.
(A) The formula suggests an oxidation state of —1 for oxygen.
(B) BaO_2 is used in the preparation of hydrogen peroxide.
(C) Peroxides are characterized by oxygen-oxygen bonds.
*(D) Barium peroxide, as well as most other peroxides, is a good oxidizing agent.

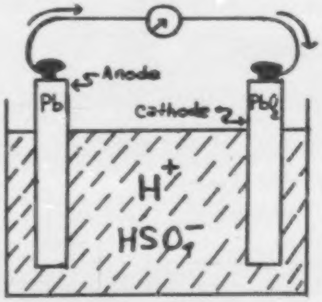
46. The indicator methyl orange is pink in acid solution and yellow in alkaline solutions.
(A) The indicator would be pink in vinegar.
*(B) The statement suggests a dissociation of the indicator, where the associated and dissociated species have different colors.
(C) At the color transition the solution is neutral if a strong acid and strong base are used.
(D) An indicator does not necessarily change color at pH 7.

47. When the salt, sodium carbonate, is dissolved in water, the resulting solution is basic.
(A) This is an example of hydrolysis.
(B) The equilibrium of the dissociated water molecules is affected by the addition of certain salts.
(C) The statement suggests that carbonic acid, a weak electrolyte, is formed, enhancing the OH^- concentration of the solution.
*(D) The statement explains why sodium carbonate (washing soda) is a good cleaning agent.

48. The equilibrium $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$.
(A) This equilibrium reaction is the basis of the Haber Process.
(B) The reaction is a source of ammonia for the fertilizer industry.
(C) The equation suggests a larger yield of NH_3 with an increase in pressure.
* (D) Although equilibrium concentrations may change at a given temperature the equilibrium constant will not change.

49. The unit cell of sodium chloride is simple cubic.
* (A) The 3 axes are at right angles.
(B) The geometry of the cell describes the arrangement of molecules or atoms in the space lattice.
(C) NaCl crystals can be formed by evaporating a salt solution.
(D) The crystalline structure is held together by forces of attraction between ions.

Items 50 and 51 apply to the following galvanic cell.



50. (A) This cell is commonly called the lead storage battery.
(B) The device in the diagram is used as a source of electricity in automobiles.
(C) The overall reaction can be written as two half-reactions describing the occurrence at each electrode.
* (D) The diagram suggests that negative electrons flow toward the negative cathode.

51. (A) The cell's operation depends upon a conversion of chemical potential to electrical potential.
(B) The H_2SO_4 is used as an electrolyte.
* (C) The cell is a source of direct current.
(D) The amount of free energy that the cell can deliver is proportional to the amount of reacting lead.

52. Evaporation is accompanied by cooling.
(A) The cooling effect would be more noticeable if the evaporation took place in an insulated system.
(B) Mammalian body temperatures are partially controlled by evaporation from surfaces.
(C) High energy molecules near the surface overcome the attractive forces between the liquid molecules.
★ (D) If highly energetic molecules leave the liquid, the average kinetic energy of those left behind is lower.

53. When minute particles are suspended in a liquid or gas, irregular zigzag movement can be observed.
★ (A) This phenomenon is called the Brownian motion.
(B) The statement suggests that the molecules of matter are constantly moving.
(C) The rate of movement varies with particle size and temperature.
(D) This principle can be used to explain motion of pollen on water surface.

54. The energy required to break the hydrogen-hydrogen bond is 17.1 x 10^{-23} kilocalories per bond .
(A) It is reasonable to assume that, for the above example, each bonded hydrogen atom contributes half the bond energy.
★ (B) The statement suggests that differences between bond energies could be used to estimate relative electronegativites.
(C) The energy relates to the covalent bond.
(D) The principle is applied in the atomic hydrogen torch.

55. When a lithium salt is sprinkled into a Bunsen flame, a red color is imparted to the flame. Sodium gives a yellow color.
★ (A) The procedure is used to qualitatively identify lithium.
(B) This is the principle of the flame test.
(C) The statement suggests an identifying spectrum for each element.
(D) Energy is emitted when excited electrons fall back to their normal energy levels.

56. When a beam of alpha particles (positively charged) is passed through a thin metal foil, a few of the particles are scattered.
(A) This is known as the Rutherford experiment.
(B) The experiment led Rutherford to say that the positive charge of the atom is concentrated.
★ (C) The experiment shows that the nucleus of an atom is small compared to the volume of the atom.
(D) The experiment proves that more than a thin layer of metal foil is needed for protection against alpha radiation.

57. The kinetic energy of a particle is dependent upon its mass and velocity.
(A) Hydrogen gas diffuses more rapidly in air than does chlorine gas.
(B) The statement does not consider the potential energy nor the temperature of the gas.
★ (C) K.E. = $1/2mv^2$
(D) Different samples of the same material will have the same average kinetic energy at a given temperature.

58. A liquid has no characteristic shape in a container.
(A) A liquid assumes the shape of its container.
(B) The depth and breadth of a river determines the shape of the creek-bed.
(C) There are no fixed positions for the molecules of a liquid.
★ (D) The statement suggests that the molecules will occupy a position of lowest possible potential energy.

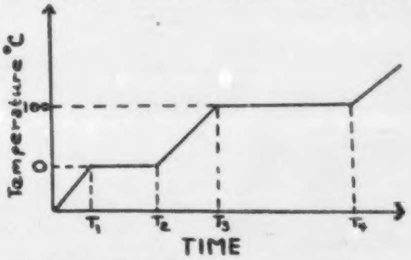
59. The rate of a reaction is proportional to the concentration of reactants raised to an appropriate power.
(A) The statement, as given above, would be more correct if the temperature of the system was considered.
★ (B) The reaction rate of burning a fuel is hastened in an oxygen atmosphere because the concentration of O_2 is increased.
(C) The slowest step in a reaction mechanism will determine the rate of the reaction.
(D) Rate = $k[A]^n [B]^m$

60. The great reactivity of the alkali metals poses a special problem in their handling.
(A) Sodium is stored under kerosene.
(B) The high oxidation potential of these metals accounts for the special handling necessary.
(C) The statement indicates the danger of handling these elements.
★ (D) Because of their activity, these metals are powerful reducing agents.

61. pH is defined as the negative log of hydrogen ion concentration.
★ (A) pH = $-\log [H_3O^+]$.
(B) The statement implies the possibility of pH values of less than zero and greater than 14.
(C) The pH of apples is approximately 3. The hydrogen ion concentration would be about 1 x 10^{-3} M.
(D) The pH of an acid or base solution changes as the solution is diluted.

62. There exist, in all matter, attractive forces between nonpolar molecules.
★ (A) The statement suggests that an electron cloud can be polarized by a neighboring neutral atom.
(B) These forces are known as van der Waals forces.
(C) The principle explains some of the properties of graphite.
(D) The force would be strongest when the particles are close together.

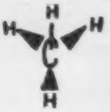
Item 63 applies to the following heating curve of water.



63. (A) From T_1 to T_2 energy is converted into disorder among the molecules.
(B) T_1 is the melting point of water.
(C) From T_1 to T_2 the average kinetic energy of the system remains unchanged.
*(D) The graph can be used to show the melting point and boiling point of water.

64. $2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$
(A) The above equation represents a laboratory preparation of oxygen.
(B) The equation is an example of a decomposition reaction.
*(C) The stoichiometric relation between $KClO_3$ and KCl is 1 mole to 1 mole.
(D) The equation suggests that $KClO_3$ is both an oxidizing and a reducing agent.

65. The methane molecule may be represented as



(A) Methane is found in natural gas.
*(B) The geometry of the molecule is a tetrahedron.
(C) The structure suggests a nonpolar molecule.
(D) The hydrogen is bonded in 4 equivalent orbitals directed to the corners of a tetrahedron.

66. $2H_2O + \text{energy} \longrightarrow 2H_{2(g)} + O_{2(g)}$
(A) This is a way of preparing pure hydrogen and oxygen.
(B) The more energy that is put into the reaction, the more H_2 and O_2 is produced.
*(C) The reverse reaction is a useful source of energy.
(D) This principle is involved in the electrolysis of water.

Item 67 applies to the following molar volume data:

Gas	Molar Volume, liters
Hydrogen	22.432
Nitrogen	22.403
Oxygen	22.392
Ideal Gas	22.414

67. (A) The data are correct only for standard temperature and pressure.
(B) The molar volume of all gases is 22.4.
(C) The ideal behavior would be figured at high temperature and low pressure.
(D) The volume represents nearly 6 gallons.

68. When most atoms combine, the bonds formed are such that each atom is surrounded by a complete octet of electrons.
(A) This is the Octet Rule or the Rule of Eight.
(B) The statement, as given above, does not apply to compounds that exceed 8 electrons in the outer shell.
*(C) This kind of configuration seems to give an atom its lowest potential.
(D) The statement above accounts for the low activity of the noble gases.

69. Equal volumes of all gases contain the same number of molecules.
*(A) This is known as Avogadro's hypothesis.
(B) The principle is employed in the determination of molecular weight of gases.
(C) The statement, as given above, is only true when the various gases are observed at the same temperature and pressure.
(D) The above principle allows us to account for the stoichiometry in reactions of combining gases.

70. An alloy is a solid solution of one metal in another.
(A) An example of an alloy is brass.
(B) The properties of an alloy are usually unlike its constituents.
(C) The structure of an alloy is usually harder than either constituent.
*(D) The strength of an alloy may be related to interstices.

71. The oxidation potential of $Zn_{(s)} \rightleftarrows Zn^{2+} + 2e^-$ is +.0.76 volts.
(A) The numerical value of the oxidation potential is related to the potential of a hydrogen electrode assigned as zero.
(B) The $Zn_{(s)}$ is oxidized.
(C) All standard oxidation potentials are measured at 293°K.
*(D) The reaction represents the oxidation half of the reaction that takes place in a flash-light cell.

72. Ammonia is very soluble in water.
(A) This property is important in the nitrogen cycle.
*(B) The resulting solution represents a dynamic equilibrium.
(C) Ammonia forms hydrogen bonds with water. This accounts in part for the enormous solubility.
(D) The result is an aqueous, ammonium hydroxide solution.

73. Within a group on the periodic table, ionization potential decreases as atomic number increases.
*(A) This is an inverse relationship.
(B) The statement implies a relationship between ionization potential and atomic radius.
(C) The increased nuclear charge down the group has little consequence because of the shielding effect of underlying electrons.
(D) Sodium is less reactive than cesium.

74. The compound, HF, etches glass.

*(A) The fact that HF etches glass in no way indicates its relative acid strength.

(B) The reaction is attributed to the formation of a fluosilicate compound.

(C) This reaction is used to etch light bulbs.

(D) HF should be stored in a wax bottle.

75. The alpha particle is identical to the helium nucleus.

(A) Alpha emission would reduce the nuclear mass by 4 atomic mass units.

*(B) An alpha source was used in the Rutherford "metal foil" experiment.

(C) The alpha particle has little penetrating power.

(D) Alpha particle emission is one mode of radioactive decay.

76. Oxygen is an odorless, tasteless, colorless gas which is more dense than air.

(A) The statement gives only physical properties.

(B) Oxygen is essential for animal life.

(C) The statement does not consider the "form" of oxygen - O, O_2 or O_3 .

*(D) Different samples of the same material will have the same properties.

77. $D = \frac{M}{V}$

*(A) This is the formula for finding the density of a substance.

(B) The formula alone does not consider the effect of temperature change on a given substance.

(C) Density is often used to identify an unknown substance.

(D) Densities of gases are much lower than those of liquids and solids.

78. Air can be liquified at —200°C by a compression and expansion process.

(A) This process is used commercially to prepare liquid oxygen.

(B) As a gas expands the molecules do work against the attraction of neighboring molecules, thus lowering the average kinetic energy.

(C) Liquid air is often used in low temperature, electrical conductance experiments.

*(D) The heat produced by compression must be removed for the liquifaction to be practical.

79. Heat + $AgNO_{3(s)}$ + $H_2O \rightleftharpoons$ solution.

(A) An endothermic solubility indicates that a salt would be more soluble at higher temperature.

(B) The reaction suggests that silver nitrate is soluble in water.

(C) The equation suggests that the lattice energy of $AgNO_3$ is greater than its hydration energy.

*(D) $AgNO_3$ solution is often used to identify the Cl^- ion.

80. The partial pressure of a gas is not changed by the pressure of other gases in the container.

(A) The total pressure in a diving bell is the sum of the pressures of the individual gases.

(B) The truth of the statement depends on having no attractive forces between molecules.

*(C) The statement is most valid at high temperature and low pressure.

(D) This is Dalton's Law of Partial Pressure.

81. The equation $H_2O \rightleftharpoons H^+ + OH^-$ is an example of an equilibrium reaction.

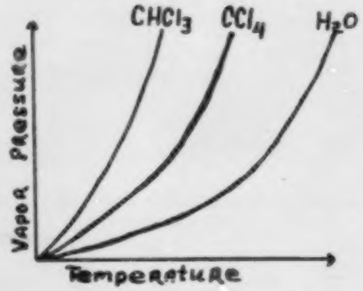
(A) Because the H_2O molecules are in great excess, the molar concentration of H_2O is essentially a constant.

*(B) $K_w = [H^+] [OH^-]$.

(C) If an acid is added to the above equilibrium, the OH^- concentration decreases.

(D) Pure water is a poor conductor of electricity.

Item 82 applies to the following graph of vapor pressure vs. temperature.



82. (A) $CHCl_3$ (Chloroform) is more volatile than the other two compounds.

(B) Because of its high volatility and anesthetic properties, chloroform should be stored in a closed container.

(C) As the temperature of a liquid increases, its pressure rises.

*(D) The data suggest that attractive forces between water molecules are larger than the forces between molecules of the other two compounds.

83. The reaction between hydrochloric acid and some metallic sulfides produces hydrogen sulfide (H_2S) gas.

*(A) Hydrogen sulfide is used in chemical analysis.

(B) Hydrogen sulfide has a very disagreeable odor.

(C) Liquid H_2S should exhibit many of the properties of H_2O.

(D) H_2S is a diprotic acid.

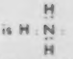
84. The density of even the heaviest atom is infinitesimally small.

(A) The atom is mostly space.

(B) $D = \frac{M}{V}$ where the denominator is very large with respect to M.

(C) The statement suggests that the density of a nucleus would be very large.

*(D) Because of the probability distribution of the electrons, the exact volume of an atom is difficult to determine.

85. The dot formula for ammonia is  $H:\overset{H}{\underset{H}{N}}:$

(A) An electron pair is available on the nitrogen atom for new bond formation.

* (B) Only the kernel and valence electrons are shown for the nitrogen atom.

(C) Since the electronegativity of H and N are quite similar, covalent bonds can be expected.

(D) The above structure can give the chemist a physical model upon which he can picture reactions involving ammonia.

86. Concentrated hydrochloric acid reacts with metals which are more active than hydrogen.

(A) This information can be obtained from the electromotive force series.

(B) For convenience, the voltage of the standard hydrogen electrode is given a value of zero.

* (C) The statement suggests that hydrogen will react with metals less active than itself.

(D) This process is used in pickling metals.

87. Vegetable oils become fats by combining the oil with hydrogen.

*(A) Crisco is the result of such a process.

(B) The process is called hydrogenation.

(C) Hydrogen can be added to certain unsaturated covalent bonds.

(D) Addition of hydrogen to vegetable oils liberates heat. Saturated fats are therefore more stable than unsaturated fats.

88. When barium chloride is added to a sodium sulfate solution, a precipitate of barium sulfate forms.

* (A) Usually the greater the charge of an anion and cation the less soluble the salt will be.

(B) This is an analytical test for sulfate.

(C) Addition of barium ion to the solution further decreases the amount of barium sulfate in solution.

(D) Barium sulfate is insoluble in water.

89. Zero on the centigrade scale corresponds to 32 on the Fahrenheit scale.

(A) It is important only that a measuring device have a reference point.

(B) A thermometer scale is a measure of the average kinetic energy of the molecules of the substance whose temperature is being determined.

*(C) $F = 9/5\,C + 32$.

(D) Both scale readings represent the freezing point of water.

The following is data on hydrides from Group VI A. Apply this data to item 90.

COMPOUND	BOILING POINT
H_2O	100°C
H_2S	—60°C
H_2Se	—40°C
H_2Te	0°C

90.*(A) The data can be explained by the hypothesis of strong hydrogen bonding between water molecules.

(B) Generally, boiling points increase with an increase in molecular weight.

(C) Water would be the best solvent at room temperature.

(D) Hydrogen bonding increases the attractive forces between molecules.

91. Heterogeneous reactions involve more than one phase.

* (A) Air (gas phase) rusts iron (solid phase).

(B) Homogeneous reactions involve a single phase.

(C) The statement suggests that the reaction rate of a heterogeneous system would be proportional to the area of contact between the phases.

(D) The rate of a reaction depends on the concentration of reactants.

92. The electron transfer equation for sodium and chlorine is $2Na\cdot + :\ddot{\underset{..}{Cl}}\ddot{\underset{..}{Cl}}: \longrightarrow 2Na^{+}\ :\ddot{\underset{..}{Cl}}:^{-}$

(A) Once the bond is formed, it might be difficult to distinguish between an ionic and a covalent bond.

(B) The bonding in sodium chloride is called electrovalence.

(C) The reaction produces table salt.

*(D) Bonds of high ionic character can be expected between elements of widely different electronegativities.

93. An alcohol contains at least one hydroxyl (OH) group.

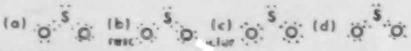
(A) It would be interesting to note whether the alcohol dissociates as an acid (H^+) or as a base (OH^-).

(B) Alcohols are good organic solvents.

* (C) R- OH is the symbol for an alcohol.

(D) Alcohols are quite easily oxidized to aldehydes.

94. The following structures can be written for sulfur dioxide:



(A) These are resonance structures.

* (B) Diagram (d) suggests odd electron bonds.

(C) The compound, no matter what the structure, is used as a bleach.

(D) The actual structure of such a molecule is said to be a resonance hybrid.

95. A water solution containing acetic acid and sodium acetate maintains a fairly constant pH value even though acid is added.

(A) This is known as a buffer.

(B) Addition of an acid to this system would result in the formation of acetic acid, a weak acid.

(C) The system appears to be dependent upon the nature and concentration of the salt.

*(D) Human blood is buffered.

96. A colloidal suspension is a system having dispersed particles suspended in a dispersing medium.
   (A) Jello is a colloidal suspension.
   (B) The particle size lies between 10^{-5} and 10^{-7} cm.
 * (C) Colloidal particles do not separate out at any appreciable rate.
   (D) The statement suggests that the system is neither obviously homogeneous nor obviously heterogeneous.

97. Following are two "solubility equations":

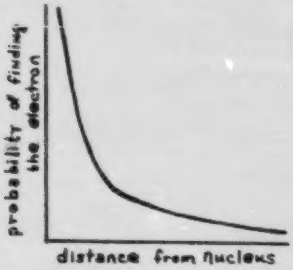
(1) $CCl_4 + H_2O \longrightarrow CCl_4 + H_2O$

(2) $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

 * (A) "Likes dissolve likes."
   (B) The information suggests that CCl_4 is geometrically symmetrical
   (C) CCl_4 is not soluble in H_2O.
   (D) Solubility depends on the nature of the solvent, nature of the solute, temperature and pressure.

98. A dilute solution is one which contains a small amount of solute.
   (A) Vinegar is a dilute acetic acid solution.
 * (B) The amount of solute is small relative to what?
   (C) Dilute solutions enhance the dissociation of solute particles.
   (D) The concentration of the solution may be increased with the addition of more solute.

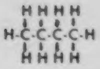
The following graph of the spatial distribution of the hydrogen electron applies to item 99.



99. (A) It appears that the electron position is not fixed.
   (B) The electron of the hydrogen atom follows a circular path about the nucleus.
   (C) Nowhere is the probability of finding an electron equal to zero.
 * (D) Because hydrogen gas molecules are very small, the gas diffuses more quickly than other gases under the same conditions.

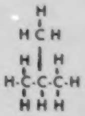
100. Many molecular formulas can be represented by more than one structure.
 * (A) This statement explains the existence of such a large number of organic compounds.

(B)



$$\begin{array}{ccccccccc} & & H & & H & & H & & H \\ & & | & & | & & | & & | \\ H & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | \\ & & H & & H & & H & & H \end{array}$$

And



   (C) Spatial relations may prevent the formation of some isomeric species.
   (D) Rubbing alcohol is an isomer of propyl alcohol.

KEY TO SUBTESTS

Subtest	Item Numbers
Memory	1,5,9,13, ...97
Critical Questioning	2,6,10,144, ...98
Practical Application	3,7,11,15, ...99
Fundamental Principle	4,8,12,16, ...100

COGNITIVE PREFERENCE EXAMINATION - II

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Reference: Atwood, Ronald K. "A Cognitive Preference Examination Using Chemistry Content." Journal of Research in Science Teaching, Vol. 5:34-35.

DIRECTIONS

PLEASE FILL-IN YOUR NAME WITH PENCIL ON THE ANSWER SHEET PROVIDED. PLEASE ALSO WRITE-IN YOUR MAJOR IN THE SPOT ON YOUR ANSWER SHEET LABELLED "COURSE". SIGN THE ANSWER SHEET IN THE SPOT LABELLED "SIGNATURE".

IN THIS TEST A STATEMENT OR OTHER PIECE OF INFORMATION IS FOLLOWED BY THREE CHOICES. EACH CHOICE IS CORRECT OR A REASONABLE OPINION. YOU ARE TO SELECT THE ONE CHOICE YOU PREFER OR LIKE BEST AND BLACKEN THE CORRESPONDING SPACE ON YOUR ANSWER SHEET WITH PENCIL. SELECT ONLY ONE CHOICE FOR EACH QUESTION AND DO NOT OMIT ANY QUESTIONS. THERE IS NO ONE "RIGHT" ANSWER. REMEMBER TO READ ALL THREE CHOICES CAREFULLY BEFORE MAKING A SELECTION.

DO NOT LABOR TOO LONG ON ANY ONE QUESTION. SELECT THE CHOICE YOU LIKE OR PREFER BEST. IT HAS BEEN FOUND THAT MOST STUDENTS TAKE 10-15 MINUTES TO COMPLETE THIS TEST.

NOTE: Each distractor is keyed according to the following code:

Application,	A
Memory,	M
Questioning	Q

1. Atomic theory considers matter to be made of fundamental units called atoms.

M (a) Over one hundred different atoms, each with a unique set of properties, have been identified.
Q (b) Protons and electrons might be considered more fundamental than atoms.
A (c) An atomic model is highly useful in the study of matter.

2. The quantity of an item produced is determined by the demand for it.

Q (a) The weakness of the generalization is indicated by existing surpluses.
A (b) A successful manufacturer must be sensitive to customer needs.
M (c) "Supply and demand" is studied by economists.

3. A historian interprets past events for mankind.

A (a) The lessons of the past influence our decisions for the future.
Q (b) The personal biases of the historian limits the usefulness of his work for decision making.
M (c) A historian's interpretation may be based on an analysis of many documents.

4. All stars are thought to be gigantic nuclear reactors.

M (a) The sun is the star nearest the earth.
A (b) The sun and other stars provide heat and light for the earth and other planets.
Q (c) There are differences among stars.

5. All objects absorb and radiate energy.

M (a) Dark colored objects absorb heat very readily.
Q (b) Generalizations of this type should be made with caution, since they are often disproved.
A (c) There are differences among stars.

6. One might think of a smile as an outward indication of inward happiness.

DISTRACTOR (a) Fewer muscles are required to smile than to frown.
ITEM (b) A smiling child is an appealing sight.
(c) A smiling subject has become somewhat traditional for photographs.

7. Beautiful flowers have been a source of inspiration to man for centuries.

A (a) Man, appreciating their beauty, has written famous poems about flowers.
M (b) Many new hybrid varieties of flowers have been developed.
Q (c) Allergies produced by flowering plants are less than inspiring.

8. In the public's interest, massive extermination efforts have often been directed toward a particular pesky insect.

A (a) By spraying mosquitoes, malaria has been controlled in the United States.
Q (b) The adverse effects of insecticides have generally not been balanced against the advantages of using them.
M (c) DDT remains one of the most effective insecticides available to man even though it's use is controversial.

9. The rate water evaporates is affected by how much moisture is already present in the air.

M (a) The amount of moisture in the air relative to how much it could hold, under a given set of conditions, is called relative humidity.
Q (b) Other variables, such as temperature and wind speed, should also be considered.
A (c) This explains why perspiration evaporates so slowly in humid weather.

10. When a nuclear reaction occurs, a huge amount of energy may be released.

Q (a) Many nuclear reactions, such as one which causes a watch dial to glow, do not appear to produce hugh amounts of energy.
M (b) The reacting materials lose mass which is changed to energy.
A (c) In the future nuclear devices may provide a means of rapid excavation for lakes and canals.

11. It is often taught that light travels in a straight line.

A (a) This information is used in explaining angles of reflection from a mirror.
Q (b) It should be noted that light does bend around corners to some extent.
M (c) One of the most exciting contemporary developments in optics is the laser.

12. Through the years, newspapers have played a major role for citizens desiring to keep well informed.

A (a) Many people, recognizing the importance of newspaper, read tow or more each day.
Q (b) Newspapers are often more interested in selling a point of view than presenting news.
M (c) There exists an Associated Press correspondent in most areas of the world.

13. The density of an object can be used to predict whether it will sink or float in water.

M (a) The density of water is approximately one gram per milliliter; the density of most wood is less.
Q (b) The shape of an object can be more important than its density in making sink or float predictions.
A (c) On the basis of density greater than one gram per milliliter, a ball of aluminum is predicted to sink in water.

14. The advantages to one's health of staying slim receive considerable promotion in our society.

A (a) Since our society is weight conscious, dietary foods have become a multi -million dollar industry.
M (b) Over-weight persons have a high rate of heart disease, diabetes, and other illnesses.
Q (c) It's unfortunate that the hazards of crash diets and diet pills do not receive comparable publicity.

15. X-rays serve man in many ways.

(a) X-rays have a greater penetrating power than light rays.
DISTRACTOR (b) X-rays are shorter than light rays.
ITEM (c) X-rays can be stopped conveniently with lead shielding.

16. Cities under the sea are now being forecast.

Q (a) The psychological desirability of such a move has not received the attention that feasibility has received.
M (b) In laboratory tests small mammals have been able to breathe underwater by using special equipment.
A (c) The realization of such cities could reduce growing population pressures.

17. Any regularly recurring event may be used as a timing device.

A (a) Thus "clocks" can be made that utilize such things as dripping water, falling sand and swinging pendula.
M (b) The event may be naturally occurring, or it may be produced by man.
Q (c) Differences in reliability and practicability make the use of just any regularly recurring event unlikely.

18. "Checks and balances" are built into the United States Government.

M (a) Power is shared by Congress, the Supreme Court and the President.
A (b) Measures approved by Congress may be vetoed by the President or declared unconstitutional by the Supreme Court.
Q (c) In a short-termed situation the checks can be inadequate to provide a balance of power.

19. It has been predicted that supersonic transport planes will provice the next major surge in commercial aviation.

Q (a) These predictions, which tend to ignore the damage that may result from sonic booms, could be unrealistic.
A (b) Aircraft manufacturers are developing supersonic passenger planes with capacities of about 500 persons.
M (c) Transportation of passengers by air has increased rapidly during recent years, while travel by rail has steadily declined.

20. Groups of students have common personality traits.

A (a) By studying these common traits, a teacher can better understand his class.
M (b) The study of personality traits of students is often the focal point in group dynamics.
Q (c) While some groups are very much alike, many differ markedly.

21. Electricity is a very versatile form of energy.

(a) Electricity is a "stream" of electrons.
DISTRACTOR (b) Electricity is often measured in kilowatt hours.
ITEM (c) Many different fuels power generators to produce electricity.

22. Sound is produced by a vibration; the rate of vibration determines the pitch of a sound.

Q (a) It should be noted that some vibrations produce no sound, and that these have no pitch.
M (b) The human ear can generally hear vibrations in the range of 50-18,000 vibrations per second.
A (c) With this knowledge man can construct an instrument to produce any pitch desired.

23. The pressure of a gas is directly proportional to its temperature.

Q (a) This statement is Gay-Lussac's Law.
A (b) This statement is not complete because it says nothing about volume.
M (c) This is why air should be added to your tires in the winter.

24. Variation is the structure of snowflakes appears endless; it has been said that no two snowflakes are alike.

Q (a) Considering the number of snowflakes that have fallen, it's hard to believe no two have been alike.
M (b) The lacey-appearing patterns could provide ideas for fabric prints and other commercial uses.

25. As the human population has increased, populations of many other organisms have diminished.

M (a) The wholesale slaughter of animals, such as the buffalo and elephant, has occurred repeatedly.
A (b) This problem has united conservationists in their efforts.
Q (c) The inferred cause-effect relationship is likely not valid for some diminishing populations.

26. Carbohydrates are often called energy foods.

M (a) All sweet and starchy foods, which includes much of what we eat, are carbohydrates.
A (b) Some athletes eat simple sugars during breaks in athletic contests for quick energy.
Q (c) Fats yield more than twice the energy of carbohydrates for a given weight.

27. The reciprocal of a number is one divided by that number.

Q (a) Multiplying by 1/4 accomplishes the same result as dividing by 4.
A (b) The above statement is not true if the number is zero.
M (c) The multiplicative inverse of a number is the reciprocal.

28. The story of life is found in rocks of the earth's crust.

M (a) Sedimentary rocks like limestone provide an excellent source of fossils and are easily obtained in many areas.
Q (b) The story of like may go well beyond the earth's crust, even to other planets.
A (c) Fossil records enable scientists to infer earlier climatic changes that have affected life.

29. One of the most fruitful areas of study in the biological sciences involves interrelationships among populations of organisms, soil, water, sunlight, and air.

Q (a) The difficulty in identifying all of the pertinent variables in this type of study limits its validity.
A (b) Studies in this area are useful in predicting how the supply of one organism affects others.
M (c) In defining a population, the location and time of observation should be identified rather specifically.

30. Medical science has produced medication for just about everything.

A (a) Through proper medication, illnesses of many origins have been controlled in some cases -- virtually eliminated in others.
M (b) Large quantities of money and research time are required for the development of new drugs by medical science.
Q (c) Drug abuse, cancer, and mental illness continue largely unchecked to discount the generalization.

SCIENTIFIC CURIOSITY INVENTORY

James R. Campbell
University of Pennsylvania
Graduate School of Education
3700 Walnut Street
Philadelphia, Pennsylvania 19174

Reference: Campbell, James Reed. "Cognitive and Affective Process Development and It's Relation to a Teacher's Interaction Ratio." Journal of Research in Science Teaching, Vol. 8, No. 4:317-323, 1971.

Scientific Curiosity Inventory Key
*

Directions: 1. Total all 1.0 "yes" answers (max. = 18 pts.).

2. Total all 2.0 "yes answers (max = 18 pts.).

3. Total all 3.0 "yes" answers (max. = 18 pts.).

Set 1 Physics
*

A 1.1
B 1.1
1 1.3
2 2.2
3 2.3
4 3.1
5 3.1

Set 2 Earth Sci.

C 1.1
D 1.1
6 1.3
7 2.2
8 2.3
9 3.1
10 3.1
11 3.3

Set 3 Biology

E 1.1
F 1.1
12 2.2
13 2.3
14 3.3
15 3.1
16 3.2

Set 4 Physics

G 1.1
H 1.1
17 2.2
18 2.2
19 2.2
20 3.1
21 3.1
22 3.3

Set 5 Earth Sci.

I 1.1
J 1.1
23 2.2
24 2.2
25 2.3
26 3.1
27 3.3

Set 6 Biology

K 1.1
L 1.1
28 1.3
29 2.2
30 2.3
31 2.2
32 3.1
33 3.1

Set 7 Chemistry

M 1.1
N 1.1
34 1.3
35 2.2
36 2.3
37 2.2
38 3.2
39 3,3
40 3.1

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* Refer to levels of the Taxonomy of Educational Levels: Affective Domain after Krathwohl, Bloom, and Masia.

Scientific Curiosity Inventory

DO NOT WRITE ANY ANSWERS IN THE QUESTION BOOKLET

Directions: The following items do not represent a test because there are no right or wrong answers. This instrument is an inventory which will attempt to measure how far you will go to satisfy your scientific curiosity. For each question check the appropriate answer on the answer page. If you should have any doubts about your response to a question, simply check the no space. Do not become concerned about the number of yes or no answers you select; simply try to be as honest and frank as possible.

Set 1

Have you ever wondered:

A. Why objects falling from high above the ground move faster as they fall?
B. Why the H bomb has so much power?

1. I would like to hear more about the special aspects of these questions.

2. I would join a science club to answer my curiosity about such questions.

3. I enjoy finding answers to questions like these.

4. After reading a story about the life of a scientist who asked questions like these, I sometimes try to become like a scientist.

5. To know the why's, what's, and how's about such science questions is important to me.

Set 2

Have you ever wondered:

C. Why the earth has magnetism?
D. How volcanoes are made?

6. I would very much like to find an answer to one of these questions.

7. In any discussion about such matters I would have several important questions to ask.

8. I get satisfaction from asking questions about such things.

9. After seeing a film about such questions, most of the time I talk to my friends about the ideas presented in the film.

10. I find it a valuable experience to do experiments to find out about questions like these.

11. My curiosity about such questions has influenced what I hope to be in life.

Set 3

Have you ever wondered:

E. How a microscope works?
F. How your heart works?

12. I would listen to a radio show to find out information and explanations about such topics.

13. I enjoy doing experiments to discover the answer to such questions.

14. I have started on rather large reading programs to satisfy my curiosity about science questions like these.

15. I look for friends who share an interest in finding out about questions like these.

16. Whenever I come across questions like these, I look for all possible explanations.

Set 4

Have you ever wondered:

G. How a TV works?
H. How a satellite stays up?

17. I would do easy experiments to find the answer to one of these questions.

18. I would take up a hobby to find answers to one of these questions.

19. I would, on my own, watch a TV show which gave me information and helped explain such questions.

20. I have an added liking for deeper and more clearly understood explanations about questions like these.

21. Finding answers to such questions is valuable to me personally.

22. I have tried to find out if scientific curiosity has lead to any definite discoveries in science.

Set 5

Have you ever wondered:

I. Why earthquakes take place?
J. What makes wind?

23. I would on my own gather many science items in order to answer my questions about such matters.

24. I would certainly have something to say in a discussion about these questions in order to find the answer to them.

25. I have developed a sharp interest in such questions.

26. Whenever I hear such questions not explained clearly, I make sure I get more information on my own to make the answer clear to me.

27. I often send away to one of the scientific supply houses for materials to satisfy my curiosity about questions like these.

Set 6

Have you ever wondered:

K. How fish breathe under water?
L. How drugs help the body fight disease?

28. I am intrigued to find out about one of these questions.

29. I would, on my own, watch a film which gave me information and helped explain these questions.

30. I enjoy joining in a good discussion about such questions.

31. I would, on my own, read a book, newspaper, or magazine article to find out about the above questions.

32. The practice of exploring ideas about such questions is important to me.

33. After seeing a TV show about such questions, I discuss, for the most part, the ideas of the show with my friends.

Set 7

Have you ever wondered:

M. What atoms and molecules are?
N. Why somethings burn and others do not?

34. I would be interested in hearing about the special applications of one of these questions.

35. I would, on my own, look for the answer to one of these questions.

36. I enjoy studying about questions like these.

37. I would, on my own, go on a field trip to find the answer to one of these questions.

38. My need to know the answers to questions like these is very important to me.

39. I often go to meetings to find out the answers to questions like these.

40. After I read a story about the life of a scientist, I become interested in doing research to answer questions like these.

HOW I FEEL

Leopold E. Klopfer
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NAME______________________________________

1. I like to go swimming. YES ? NO

2. I hate ice-cream. YES ? NO

3. I would like to help take care of the things in the science room.

YES ? NO

4. I like to study music and art more than science.

YES ? NO

5. I would like to study more science. YES ? NO

6. When the other students talk about science, I want to walk away.

YES ? NO

7. I cannot wait for science class to be over. YES ? NO

8. It is easier to think about reading questions than to think about science questions.

YES ? NO

9. I like the teacher to call on me to answer science questions.

YES ? NO

10. I would like to do more things in science class.

YES ? NO

11. I really like my science teacher. YES ? NO

12. I think science class is boring. YES ? NO

13. I hate it when the teacher calls on me to answer science questions.

YES ? NO

14. Thinking about math questions is easier than thinking about science questions.

YES ? NO

15. Science class is my favorite class. YES ? NO

16. I like to talk about the things I do in science class.

YES ? NO

17. I worry when the aide checks my science lesson booklet.

YES ? NO

18. I would like to do things with the people who make the science lessons.

YES ? NO

19. I think the other students like science class better than I do.

YES ? NO

20. The things I do in science class help me to do things outside of school.

YES ? NO

21. I get tired of doing things in science class.

YES ? NO

22. I think it would be fun to be a teacher's aide in science class.

YES ? NO

23. I like to do things in science class without the teacher telling me.

YES ? NO

24. I am afraid to make a mistake in the science lesson booklet.

YES ? NO

25. I like writing math answers ____________________ writing answers to science questions.

more than
just as much as
less than

26. I like learning spelling words ____________________ learning science words.

more than
just as much as
less than

27. I like gym class ____________________ science class.

more than
just as much as
less than

28. I like doing a tape lesson in science ______________________ doing a student activity in science.

more than
just as much as
less than

29. I like doing a student activity in science ______________ working in a group lesson in science.

more than
just as much as
less than

30. I like playing a science game _________________ going a tape lesson in science.

more than
just as much as
less than

ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

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RESPONSE SHEET

Attitude Toward Science

Not Circled - Attitude Toward Teaching Science

		Strongly	Somewhat	Neutral	Somewhat	Strongly	
		o	1	2	3	4	
1.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
2.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
3.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
4.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
5.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
6.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
7.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
8.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
9.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
10.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
11.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
12.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
13.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
14.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
15.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
16.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
17.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
18.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
19.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
20.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
21.	Agree	0	0	0	0	0	Disagree

Scoring can be done by making a stencil of this answer sheet with the numerals above the responses as shown - total the scores of circled statements and this is the score for Attitudes Toward Science. Repeat process for non-circled statements and this is the score for Attitude Toward Teaching Science.

		Strongly	Somewhat	Neutral	Somewhat	Strongly	
		4	3	2	1	o	
22.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
23.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
24.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
25.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
26.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
27.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
28.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
29.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
30.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
31.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
32.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
33.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
34.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
35.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
36.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
37.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
38.	Agree	0	0	0	0	0	Disagree
		4	3	2	1	o	
39.	Agree	0	0	0	0	0	Disagree
		o	1	2	3	4	
40.	Agree	0	0	0	0	0	Disagree

INSTRUCTIONS

In this questionaire you are asked to indicate the extent to which you agree or disagree with each statement. The agree-disagree scale has five choices for each statement.

For example, darken the space that comes closest to your feeling about the following statement:

College students have too much free time. Agree ○ ○ ○ ○ ● Disagree

Darkening the space closest to the agree side of the scale means you agree strongly with the statement; darkening the second space in from the agree side of the scale indicates you agree somewhat with the statement; darkening the middle space indicates you have no opinion or have neutral feeling about the statement; darkening the second space in from the disagree side of the scale indicates you disagree somewhat with the statement; and darkening the space closest to the disagree side of the scale indicates you disagree strongly with the statement.

AGREE-DISAGREE

Do NOT write in test booklet. Indicate your feelings on the response sheet provided.

		Strongly	Somewhat	Neutral	Somewhat	Strongly	
1. Elementary teachers should not be required to teach science.	Agree	○	○	○	○	○	Disagree
2. Newspapers and magazines should include fewer articles about science.	Agree	○	○	○	○	○	Disagree
3. Science is a subject that would be fun to teach.	Agree	○	○	○	○	○	Disagree
4. There should be more effort expended to educate the general public in science.	Agree	○	○	○	○	○	Disagree
5. The study of science gives man a better understanding of his fellowmen.	Agree	○	○	○	○	○	Disagree

		Strongly	Somewhat	Neutral	Somewhat	Strongly	
6. Too much money is being spent by the United States government for science programs.	Agree	○	○	○	○	○	Disagree
7. An elementary teacher who has a negative attitude toward teaching science can still be a very effective overall teacher.	Agree	○	○	○	○	○	Disagree
8. Our society places too much emphasis on science.	Agree	○	○	○	○	○	Disagree
9. Procedures of inquiry, as taught in science, give a student a method of study that he can employ in many other areas.	Agree	○	○	○	○	○	Disagree
10. A very stimulating, challenging and rewarding career is in store for the person who elects to teach science.	Agree	○	○	○	○	○	Disagree
11. Science teachers are envied by their colleagues because they can submit their subject arguments to the test of laboratory and demonstration.	Agree	○	○	○	○	○	Disagree
12. Too much time and money is being spent on new programs for teaching science.	Agree	○	○	○	○	○	Disagree
13. Our schools are spending too much time on science.	Agree	○	○	○	○	○	Disagree
14. Teaching science will lead to a teaching career filled with satisfaction.	Agree	○	○	○	○	○	Disagree
15. Studying science courses causes a student to be more tolerant toward contrary viewpoints.	Agree	○	○	○	○	○	Disagree
16. Funamentally the goals of science and the attributes of good citizenship are similar.	Agree	○	○	○	○	○	Disagree
17. Elementary education students should not be required to take a science methods course.	Agree	○	○	○	○	○	Disagree

			Strongly	Somewhat	Neutral	Somewhat	Strongly	
18.	Replacing science courses with courses in other disciplines would be an improvement in a school's curriculum.	Agree	○	○	○	○	○	Disagree
19.	The only benefit received from the work of scientists is the production of technical gadgets.	Agree	○	○	○	○	○	Disagree
20.	Elementary teachers should enjoy teaching science.	Agree	○	○	○	○	○	Disagree
21.	If you are looking for an area to teach that will provide opportunities for students to express their initiative and ingenuity you should choose science.	Agree	○	○	○	○	○	Disagree
22.	To have a good understanding of the world in which we live one needs to study science.	Agree	○	○	○	○	○	Disagree
23.	As a future elementary teacher I am not looking forward to teaching science.	Agree	○	○	○	○	○	Disagree
24.	Science is a dull subject to teach.	Agree	○	○	○	○	○	Disagree
25.	Time studying science could be more profitably used studying other areas.	Agree	○	○	○	○	○	Disagree
26.	A person studying science will tend to become a dull misfit in our society.	Agree	○	○	○	○	○	Disagree
27.	Teaching science is more like a hobby or recreation to a teacher rather than another job or chore.	Agree	○	○	○	○	○	Disagree
28.	Studying science helps one make judgements more objectively than emotionally.	Agree	○	○	○	○	○	Disagree
29.	Science in elementary grades should be taught by men teachers only.	Agree	○	○	○	○	○	Disagree
30.	Instead of helping eliminate ignorance and superstition from mankind, science has tended to increase it.	Agree	○	○	○	○	○	Disagree

		Strongly	Somewhat	Neutral	Somewhat	Strongly	
31. Teaching science gives a person a means of expressing himself creatively.	Agree	○	○	○	○	○	Disagree
32. If the opportunity developed I would encourage others to teach science.	Agree	○	○	○	○	○	Disagree
33. A true scientist does not believe in God.	Agree	○	○	○	○	○	Disagree
34. To be ignorant of the methods of science leaves a student unprepared for their place in society.	Agree	○	○	○	○	○	Disagree
35. I have no desire to teach science.	Agree	○	○	○	○	○	Disagree
36. Only the teachers of grades eight through twelve need be concerned with teaching science.	Agree	○	○	○	○	○	Disagree
37. As a future elementary teacher I am looking forward to teaching science.	Agree	○	○	○	○	○	Disagree
38. The aim of science is to help us understand the world and ourselves.	Agree	○	○	○	○	○	Disagree
39. As a group, scientists are concerned with overcoming the ills of our society.	Agree	○	○	○	○	○	Disagree
40. If teaching science were removed from the elementary grades, teaching at this level would be more pleasant.	Agree	○	○	○	○	○	Disagree
41. Grouping elementary education students for the study of science produces a better learning situation for the students involved.	Agree	○	○	○	○	○	Disagree
42. If you had to design a physical science course to fit the needs of future elementary teachers your approach would be very similar to the one used in your present course.	Agree	○	○	○	○	○	Disagree

THE METHODS AND PROCEDURES OF SCIENCE: AN EXAMINATION

John Woodburn
9208 Le Velle Drive
Chevy Chase, Maryland

Name______________________________ Grade in School__________ Score__________

THE METHODS AND PROCEDURES OF SCIENCE: AN EXAMINATION

Part I.
1. 0 ● 0 0 0
2. 0 0 0 0 ●
3. ● 0 0 0 0
4. 0 0 0 ● 0
5. 0 0 ● 0 0

6. 0 0 0 0 ●
7. ● 0 0 0 0
8. 0 0 0 ● 0
9. 0 0 ● 0 0
10. 0 0 0 0 ●

11. 0 ● 0 0 0
12. 0 0 ● 0 0
13. 0 ● 0 0 0
14. 0 0 0 0 ●
15. 0 0 ● 0 0

16. ● 0 0 0 0
17. 0 0 0 ● 0
18. 0 0 ● 0 0
19. 0 0 ● 0
20. 0 0 ● 0 0

21. 0 ● 0 0 0
22. 0 0 0 0 ●
23. 0 0 0 ● 0
24. 0 ● 0 0 0
25. ● 0 0 0 0

26. 0 0 ● 0 0
27. 0 0 0 0 ●
28. 0 0 0 0 ●

Part II.
29. 0 0 0 ● 0
30. ● 0 0 0 0

31. 0 ● 0 0 0
32. 0 0 0 ● 0
33. 0 0 0 0 ●
34. 0 0 ● 0 0

Part III.
35. ● 0 0 0 0

36. 0 0 ● 0 0
37. 0 0 0 0 ●
38. 0 0 0 ● 0
39. 0 ● 0 0 0
40. 0 0 ● 0 0

41. 0 0 ● 0 0
42. 0 0 0 0 ●
43. ● 0 0 0 0
44. 0 ● 0 0 0
45. 0 0 0 ● 0

46. ● 0 0 0 0
47. ● 0 0 0 0
48. 0 0 0 ● 0
49. 0 ● 0 0 0
50. 0 0 0 0 ●

TO THE TEACHER: No special directions are needed to administer this examination. It is best to pass out the answer sheets first and then the test booklets. Copy a sample answer space (1. 0 0 0 0 0) on the chalkboard and show the students they are to blacken in the zero that is to be their choice of answer. Explain that some of the choices in some of the KEY LISTS may be used more than once and some may need to be used not at all.

Try to give the students at least 40 but not more than 45 minutes of actual working time.

Make no "corrections" for guessing but simply report total raw score.

THE METHODS AND PROCEDURES OF SCIENCE: AN EXAMINATION

> "The greatest invention of the nineteenth century was the invention of the method of invention." --- Alfred North Whitehead, 1925.

A teaching as well as testing exercise to help teachers keep track of their students' progress in gaining the vocabulary and doing some of the kinds of thinking that are done in the pursuit of science.

DIRECTIONS: When you are to begin and finish and how you are to mark your answer sheet will be explained by your teacher. Please do NOT put any kinds of marks in this booklet.

This examination has been developed with help volunteered by these members of the National Science Teachers Association:

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Max Benzofsky, Towsontown Junior High School, Towson, Maryland
Mortimer L. Bloom, Brooklyn College of the City University of New York
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Part I. The Meanings of Words Used in the Pursuit of Science.

For items 1 through 6, choose from the KEY the word that is BEST defined by the statement. In this and following exercises, you may need to use parts of the KEY more than once.

KEY:
1. Problem.
2. Hypothesis.
3. Assumption.
4. Experiment.
5. Observation.

1. A possible solution to a problem.

2. A result from using our senses on a bit of the world around us.

3. An incompletely described or understood event or situation.

4. Planned efforts to observe an event or situation.

5. Something that is orderly enough to let us take for granted that it will act or be as we think it will.

6. A record of an actual happening or event in time or space.

* * * * *

For items 7 through 12, choose from the KEY the word that is BEST defined by the statement.

KEY:
1. Generalization.
2. Deduction.
3. Definition.
4. Analogy.
5. Postulate.

7. Using a set of observations or conclusions to understand events in addition to those which have been observed.

8. The idea that things which are alike in some ways may be similar or related in other ways.

9. The properties of something which distinguish it from all other "somethings."

10. If this is accepted as being true, then ideas and conclusions developed from it can be claimed to be true.

11. Believing that if an event belongs to a particular group of events, then whatever is true for the group is true for the event being investigated.

12. A statement of the meaning to be given to a word or symbol.

* * * * *

For items 13 through 18, choose from the KEY the word that is BEST defined by the statement.

KEY:
1. Average.
2. Median.
3. Bias.
4. Variable.
5. Control.

13. A value above and below which fall an equal number of related values.

14. Something supposedly kept the same in different parts of an experiment.

15. Something likely to "coax" an investigator to "adjust" his observations one way or another.

16. A value that represents the middle point between extremes.

17. Something that is allowed to change in different parts of an experiment.

18. A tendency for one's observations to give misleading information.

* * * * *

For items 19 through 22, choose from the KEY the term that the statement BEST illustrates or provides an example of.

KEY:
1. Definition.
2. Observation.
3. Assumption.
4. Hypothesis.
5. Experiment.

19. If flatworms that have been trained to respond to electrical shocks are cut in halves, then one half will retain the response better than the other half.

20. Bacteria and molds occur everwhere unless something is done to remove them.

21. Penicillin kills or prevents the growth of many kinds of organisms.

22. Twenty flatworms that had been trained to respond to electrical shocks were cut in halves Each front and back half was then given an electrical shock separately.

For items 23 through 28, choose from the KEY the criticism that BEST applies to each of the definitions.

1. The definition includes many of the basic qualities and characteristics of science.
2. The definition says what science is not.

KEY: 3. The definition fails to distinguish science from other things people do.

4. The definition doubles back to repeat what it is supposed to define.
5. The definition touches on too few of the basic qualities and characteristics of science.

23. Science is what scientists do.

24. Science is the opposite of superstition.

25. Science is man's attempt to describe nature's events and to see relationships accurately enough to allow him to understand nature's events and situations.

26. Science is doing one's best with one's mind, no holds barred.

27. Science is the discovery or invention of things like new medicines and drugs to enable mankind to live better and longer.

28. Science is the organized knowledge that has been gained from observing and classifying facts about nature.

* * * * *

Part II. Recognizing the Plan or Design of Experiments.

For items 29 through 34, choose from the KEY the type or design of experiment that is BEST illustrated in each of the statements.

1. All things believed to be necessary for the event to take place are brought together to see if the event occurs as expected.
2. Something that is believed to be necessary is taken away or left out to see if the event fails to occur.

KEY: 3. One or more of the things believed to be necessary are strengthened to see if the event occurs differently.

4. One or more of the things believed to be necessary are weakened to see if the event occurs differently.
5. The event is observed in as many different cases as possible and all accompanying conditions are recorded carefully.

29. To see if seeds hold more stored food than is taken up by the seedling before the seedling becomes self-supporting, various amounts of the seed leaves were cut away from bean seeds before they were planted.

30. To see if willow twigs which sprout roots when left standing in water give off a "rooting" hormone, several willow twigs were placed upside down in water in which right side up willow twigs had sprouted roots.

31. To see if light is necessary for green plants to carry on photosynthesis, a leaf was removed from a plant before sunrise and then the leaf was tested with iodine solution for the presence or absence of starch.

32. While seeking the cause or causes of lung cancer, an investigator set out to see if men who smoked cigars had lung cancer less often than did men who smoked pipes and if men who smoke cigarettes have lung cancer more often than do men who smoke either cigars or pipes.

33. To see if the kinds and numbers of tiny plants and animals which live in streams change as the stream becomes increasingly polluted, the living things in samples of water from a stream near the edges of a growing city were observed carefully week-by-week for a year.

34. While seeking the cause or causes of skin acne (pimples), an investigator gave several young volunteers nothing to eat for several days except chocolate candy.

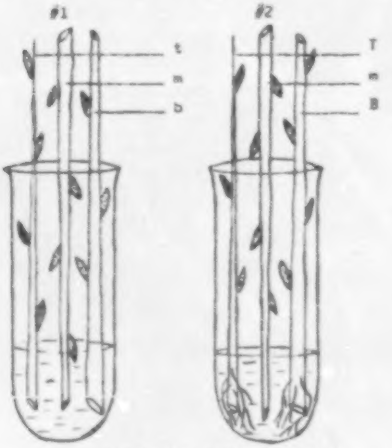
NOTE: Your teacher will tell you when you are to go ahead to Part III.

Part III. Drawing Conclusions from Experiments.

Items 35 through 40 involve the following report of a series of experiments.

If weeping willow twigs are left standing in water, roots sometimes appear near the bottoms of the twigs. This is curious because had the twigs been left on the tree, only leaves or flowers would have formed on the twigs. Four students did experiments to help them study the formation of roots on willow twigs. Each student obtained two similar twigs about 24 inches long. Each twig was then cut into thirds. The three parts of each twig were placed in a test tube with the middle part only turned upside down. The two end parts were stood in the test tube so that if water rose in the twig it would move the same way it would have moved had the twig been left on the tree and water would have moved from the roots to the twig ends. Each test tube was kept half-filled with water.

To make it easier to keep track of the results from their experiments, all tip-end parts of the twigs were labeled "T" if they developed roots and "t" if they didn't. In similar fashion, "M" and "m" and "B" and "b" were used to show whether or not the middle and bottom parts of each twig developed roots. See the diagram below which shows the results obtained from Andy's experiments.



Andy's Two Experiments

The following table summarizes the results from the 8 experiments carried out by the four students.

Student's Name	Test Tube #1	Test Tube #2
Andy	t m b	T m B
Betty	T m B	T M B
Cindy	T M B	T M B
Dick	t m b	T m B

For items 35 through 40, choose from the KEY the criticism that applies BEST to each of the following conclusions drawn from the above experiments.

1. Agrees entirely with the data from the experiments.
2. Disagrees totally with the data from the experiments.
KEY:3. The statement is both supported and contradicted by the data from the experiments.
4. The conclusion goes beyond the data actually shown by the experiments.
5. The conclusion misses the point of the investigation.

35. No roots grew on the upside down part of a twig unless roots grew on at least one of the right end up parts in the same test tube.

36. Roots will grow on a willow twig even though it is upside down in water.

37. Water evaporated from each of the test tubes during the experiments.

38. At least one of Andy's and Dick's twigs must have been dead.

39. The cells which make up the tissues in willow twigs can divide to make new cells, but the new cells will be exactly like the old cells which produced them.

40. Gravitational forces must have something to do with the appearance of roots on willow twigs that are left standing in water.

* * * * *

Go ahead to Item Number 41.

In another experiment, a student looked into the absorption of water by living and dead seeds. He prepared 6 paper packages each containing 6.40 grams of live seeds and 6 similar packages each containing 6.00 grams of the same kind of seeds that had been killed with heat. All 12 packages were kept equally warm and moist. At the end of each day for 6 days, one live and one dead seed package were taken from the experiment, the seeds were blotted dry, and weighed. All of the weights were taken on balances which are accurate within plus or minus .03 gm. The results appear in the following table.

Day	Weight of Live Seeds	Weight of Dead Seeds
0	6.40 gms	6.00 gms
1	6.67	6.24
2	7.01	6.47
3	7.34	6.83
4	7.36	7.01
5	7.34	7.34
6	7.35	7.82

For items 41 through 46, mark the statements by using the following key:

1. The statement is not a conclusion; it is simply an observation.
2. The statement is true. There is no reason to doubt it.

KEY: 3. The statement is probably true. It is supported by the data from this experiment.

4. The statement should be accepted very cautiously. It goes too far beyond the data from the experiment.
5. The statement is false. It is not supported by the data from this experiment.

41. Seeds stop absorbing water for a few days soon after they begin to sprout.

42. Seeds do not absorb water until germination begins.

43. The dead seeds gained weight every day.

44. Seeds do not have to be alive in order to have water pass through their seed coats.

45. Much of the increasing weight of the dead seeds was due to the growth of molds and bacteria.

46. On the fifth day, the live and dead seeds weighed the same.

* * * * *

Items 47 through 50 involve an experiment that was part of an effort to get rid of a type of fly which kills cattle by laying its eggs in open wounds. The eggs hatch into larvae which eat the flesh of cattle. Before this problem was solved, the loss to cattlemen in the United States ran as high as $40,000,000 a year. In an experiment, male flies were raised in a laboratory and were then sterilized by x-rays, that is, the adult flies were treated with a kind of radiation which prevented these male flies from fertilizing the eggs laid by female flies. These sterile male flies were then taken to a Caribbean island that was known to be infested with this pest.

For several weeks the sterilized male flies were released from airplanes at the rate of 400 per square mile per week. Very soon, farmers in the area noticed that the numbers of egg masses on their cattle began to decrease, and within seven weeks, the eggs which did appear were found to be infertile and, hence, didn't hatch. After several more weeks, no egg masses were found at all, the fly had been completely wiped out from the island.

For items 47 through 50, use the same key you used for items 41 through 46 to mark the statements.

47. Some kinds of insect pests can be destroyed without the use of poisons.

48. This x-ray sterilization method can be used to control all kinds of insect pests.

49. The females of this kind of fly can lay eggs even though the eggs cannot hatch into larvae.

50. Cattle visited by flies which have been sterilized by x-rays may "catch" the sterilization effects and thus become unable to produce young animals.

LEVEL OF ADOPTION SCALE FOR SCIENCE TEACHING INVESTIGATIONS

Kenneth R. Mechling
Clarion State College
Clarion, Pennsylvania 16214

Reference: Mechling, Kenneth R. A Strategy for Stimulating the Adoption and Diffusion of Science Curriculum Innovations Among Elementary School Teachers. Final Report, Project No. 9-3-053, Grant No. OEG-2-9-480053-1043 (010), United States Office of Education, Washington, D.C., 1969.

LEVEL OF ADOPTION SCALE

FOR SCIENCE TEACHING INVESTIGATIONS

A. Name of respondent ______________________________

B. Name of elementary school in which you teach ______________

C. Name of school district in which you teach ______________

GENERAL INSTRUCTIONS

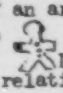
This questionnaire consists of descriptions of ten elementary science investigations lettered A through J. You are invited to read each description and decide which one of the seven statements at the top of the page best describes your present feeling about and/or use of the investigation. Indicate that statement by circling one of the numbers which appears like this 1 2 3 4 5 6 7 for each description. For example, if after reading the description of investigation A and the statements at the top of the page, you decide that you hadn't heard of investigation A before you would then circle the number 1. However, if you are using or have used investigation A in your classroom but haven't decided if you'll use it again in the future, you would circle the number 6.

PART I

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation A

This investigation concerns relativity or the positions and motions of objects relative to other objects. It involves the use of an artificial observer, Mr. O, who is made of paper and is shaped like this  For the children, Mr. O becomes a central reference object. The position of any other object either at rest or in motion is described relative to Mr. O. Children are involved in individual or group activities such as discussing Mr. O's relative position, cutting out Mr. O figures, and manipulating Mr. O's position relative to other objects.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of
1 2 3 4 5 6 7 Investigation A.

Description of Investigation B

This investigation involves children in the study of electricity and magnets. Children work individually, in pairs or in small groups using materials such as flashlight cells, bulbs, wire, tape, and nails. They investigate such things as ways to light a bulb using only a cell, a bulb, and a wire; what happens when more than one cell or bulb is used; and how to construct and use a simple electromagnet.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of
1 2 3 4 5 6 7 Investigation B.

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation C

The intention of this investigation is to encourage pupils to make careful, conscious reasoning about observations. The children must infer the characteristics of objects they cannot see. Objects such as chalk, pencils, marbles, erasers, pins, spoons, tacks, or stones are placed in containers such as cigar or shoe boxes. Children working in small groups observe, discuss, or infer the characteristics and identity of the objects in the boxes on the basis of hearing, touching, or lifting, smelling, etc.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation C.

1 2 3 4 5 6 7

Description of Investigation D

This investigation involves children in the study of the life cycles of flowering plants. Fruits such as tomatoes or bean and pea pods are examined and identified as sources of seeds. Children examine and count peas, corn, beans, or sunflower seeds. The seeds are germinated and the early growth of the embryo plant is observed. Seeds are planted in small drinking cups and children observe, discuss, measure, and record the growth and development of plants.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation D.

1 2 3 4 5 6 7

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation E

In this investigation, the children are given several common substances such as talcum powder, baking soda, and cornstarch which, on preliminary observation, seem alike. They are asked to treat them with other substances such as water, white vinegar or an iodine solution, to observe their behavior, and to record the data for future reference. The data are then used by the children in identifying known materials, and subsequently in the identification of a substance that is unknown to them.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation E.

1 2 3 4 5 6 7

Description of Investigation F

This investigation involves children in observing and measuring human reaction time. A piece of paper, yardstick, or meterstick is held between the thumb and fingers of a child and is then released. A measurement is then made of how far the paper or stick dropped before it was caught. Reaction times to such signals as light, sound, and touch are subjects of measurement. The children work together in small groups dropping and measuring, identifying variables, and providing controls.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describe your present feeling about and/or use of Investigation F.

1 2 3 4 5 6 7

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation G

In this investigation children observe and experiment with mealworms. Mealworms are the larvae of grain beetles, Tenebrio molitar, and grow to about one inch long and one-eighth inch in diameter. Children make undirected observations of the mealworm or seek to answer questions such as: Can a mealworm see? How do mealworms follow walls? How do they find a pile of bran? How can a mealworm be made to back up? In their attempts to solve these problems the pupils devise experiments, observe, measure, keep records, design and build simple equipment, attempt to control variables, and draw conclusions.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes
1 2 3 4 5 6 7 your present feeling about and/or use of Investigation G.

Description of Investigation H

In this investigation children are involved in classification and serial ordering. Objects or materials such as sandpaper, corks, wood, rocks, or minerals are grouped or classified on the basis of properties such as shape, size, color, or texture. Children work individually or in small groups observing and describing properties, developing classification systems, and ranking objects according to the degree to which they possess a certain property.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes
1 2 3 4 5 6 7 your present feeling about and/or use of Investigation H.

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation I

This investigation involves children in some simple experiments with eyedroppers and liquids such as water, soapy water, cooking oil, vinegar, etc. Liquid properties such as density, viscosity, surface tension, adhesion, and cohesion are isolated and explored. Individuals or small groups of children perform such activities as observing drops of different liquids, investigating the way different surfaces affect the size and shape of drops, determining if different liquids make different drop prints or if the distance a drop falls makes a difference in the size of the print, conducting "races" with different liquids on slanted waxed paper, and investigating what happens if a small piece of aluminum foil, cork, or toothpick has been placed on top of a "heap" of liquid. They discuss their observations and ideas and devise ways of testing to find out if their ideas are right.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation J.

1 2 3 4 5 6 7

Description of Investigation J

In this investigation the children observe, describe, and measure the motion of bouncing balls. Children work in small groups using assorted balls such as sponge rubber, ping-pong, or super balls. One child drops the ball while the others measure, discuss, and record data. They predict and determine the relationship between drop height of a ball to its bounce height and may construct bar graphs to show this relationship.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation J.

1 2 3 4 5 6 7

[TEST OF KNOWLEDGE OF SAPA]

Dale G. Merkle
Department of Elementary Education
Shippensburg State College
Shippensburg, Pennsylvania 17257

Reference: Merkle, Dale G. "A Leadership Workshop on Elementary School Science: An In-Depth Evaluation." Journal of Research in Science Teaching, Vol. 7:121-133, 1970.

DIRECTIONS: Multiple Choice. Choose the best answer.

_____ 1. Which of the following persons is the project director of AAAS?

- A. Robert M. Gagne
- B. Robert Karplus
- *C. John R. Mayor
- D. Charles Walcott
- E. Jerrold R. Zacharias

_____ 2. Which of the following persons is the project director of SCIS?

- A. Robert M. Gagne
- *B. Robert Karplus
- C. John R. Mayor
- D. Charles Walcott
- E. Jerrold R. Zacharias

_____ 3. The grade levels to be included in Science--A Process Approach are:

- A. K-16
- B. K-12
- C. K-8
- *D. K-6
- E. 1-6

_____ 4. The grade levels to be included in the SCIS curriculum are:

- A. K-16
- B. K-12
- C. K-8
- *D. K-6
- E. 1-6

_____ 5. The main funding agency for AAAS is:

- A. American Association for the Advancement of Science
- *B. National Science Foundation

C. National Science Teachers Association
D. United States Office of Education
E. University of California

_____ 6. The main funding agency for SCIS is:

A. American Association for the Advancement of Science
* B. National Science Foundation
C. National Science Teachers Association
D. United States Office of Education
E. University of California

_____ 7. The current publishing agency (if any) for AAAS is:

A. Holt, Rinehart, Winston
B. Harcourt, Brace and World
C. Rand McNally
D. Raytheon
* E. Xerox

_____ 8. The current publishing agency (if any) for SCIS is:

A. Holt, Rinehart, Winston
B. Harcourt, Brace and World
C. Rand McNally
* D. Raytheon
E. Xerox

_____ 9. The approximate cost of a complete set of AAAS materials per class (30 students) in grade one is:

A. $450
* B. $350
C. $250
D. $150
E. $50

_____10. The approximate cost of SCIS materials per class (32 students) in grade one is:

* A. $450
B. $350
C. $250
D. $150
E. $50

_____11. The final commercial edition of AAAS materials that will be commercially available for 1968-69 are:

A. Science--A Process Approach Parts I-II only
B. Science--A Process Approach Parts I-III only
*C. Science--A Process Approach Parts I-IV only
D. Science--A Process Approach Parts I-VI only
E. Science--A Process Approach Parts I-VII

_____12. The SCIS materials that will be commercially available for 1968-69 are:

*A. Interaction, Life Cycles, Material Objects, Organism, Relativity, and Subsystems
B. Interaction, Material Objects, Organisms, Relativity, and Subsystems
C. Interaction, Material Objects, Organisms, and Subsystems
D. Interaction, Material Objects, Organisms
E. None of the above are correct

_____13. The AAAS evaluation instruments that will be commercially available for 1968-69 are:

A. The "Process Instrument"
B. The "Competency Measures" for all grades covered by Science--A Process Approach
*C. Both the "Process Instrument" and the "Competency Measures"
D. No evaluation instrument will be commercially available

_____14. The SCIS evaluation instruments that will be commercially available for 1968-69 are:

A. The "Process Instrument"
B. STEP
C. The "Content Instrument"
D. The "Materials and Interaction" instrument
*E. No evaluation instrument will be commercially available

_____15. The primary evaluation emphasis of SCIS has been on:

A. Comparing students who have had SCIS with those who have not
B. A definitive measure of the scientific literacy of the pupils emerging from SCIS courses
*C. Evaluating the program by collecting feedback information from teachers and Trial Center Coordinators

_____16. AAAS materials that will be available for teacher workshops in 1968-69 include:

A. "Commentary for Teachers"
B. "Guide for the Instructor of a Teacher Education Program"
*C. Both A and B
D. None

_____17. SCIS materials that will be available for teacher workshop in 1968-69 include:

A. SCIS Developmental Skill Commentary
*B. "SCIS Sourcebook"
C. Both A and B
D. None

_____18. The major psychological influence on the AAAS program?

A. Bruner
*B. Gagne
C. Piaget
D. Skinner
E. Thorndike

_____19. The major psychological influence on the SCIS program?

A. Bruner
B. Gagne
*C. Piaget
D. Skinner
E. Thorndike

_____20. Piaget's ideas of development have influenced both AAAS and SCIS. Which statement(s) best illustrate this school of thought?

A. Development is limited to external situations, and is thereby provoked.
B. Children's intellectual capacity passes through a number of qualitatively contrasting stages before adulthood.
C. A child's interaction with his environment plays a very significant role in his transition from one stage to another.
D. A child can learn any subject matter at any stage of his development.
E. Combination of A and B
*F. Combination of B and C
G. Combination of B and D

_____21. The AAAS curriculum makes use of hierarchy charts. Which of the following statements about them is most accurate?

*A. They illustrate the types of skills considered, and the relationships among skills within one process and among the several processes.
B. They only illustrate the types of skills considered, and the relationships among skills within one process.
C. They only illustrate the types of skills considered in flow chart form.

22-23 In comparing AAAS and SCIS approaches to the integration of their curricula, one can find significant differences in emphasis in the three elements: concepts, phenomena, and processes.

_____22. AAAS is structured on

A. Concepts
B. Concepts and Phenomena
C. Concepts and Processes
D. Phenomena
*E. Processes

_____23. SCIS is structured on

A. Concepts
*B. Concepts and Phenomena
C. Concepts and Processes
D. Phenomena
E. Processes

_____24. The relative importance of sequencing in the SCIS and AAAS programs:

A. Important only in AAAS
B. Important only in SCIS
*C. Important in both
D. None are sequenced

_____25. The relative amount of quantitative science incorporated in the SCIS and AAAS programs:

A. More quantitative science in SCIS than AAAS
*B. More quantitative science in AAAS than SCIS
C. Both have about the same amount of quantitative science
D. Little or no quantitative science incorporated in either program

_____26. The primary objective of each of the exercises in the AAAS curriculum is:

A. to gain a better understanding of a science principle
B. to gain scientific literacy
*C. to teach one or more of the processes of science
D. the development of competent scientists
E. None of the above correct

_____27. The primary purpose of the SCIS curriculum is:

A. the development of competent scientists
B. to develop more meaningful science materials for children
C. the development of specified process skills
*D. the development of scientific literacy
E. None of the above

_____28. By "invention" lesson in SCIS, we mean:

A. the children recognize a scientific principle when presented with various examples of a concept
B. the children create new solutions to problems
*C. the teacher introduces the science concept that describes what the children have observed
D. None of the above are correct

_____29. In the "discovery" lesson in SCIS:

- *A. experiences are provided that present further examples of a previously described concept
- B. materials are provided whereby children can arrive at a scientific principle without teacher prompting
- C. students study the history of famous scientific discoveries
- D. None of the above are correct

_____30. The average amount of time required to teach each of the AAAS units (e.g., part A) in the elementary schools is about:

- A. 11-12 months
- *B. 8-10 months
- C. 5-7 months
- D. 3-5 months
- E. 1-2 months

_____31. The average amount of time required to teach each of the SCIS units (e.g., Organisms) in the elementary schools is about:

- A. 11-12 months
- B. 8-10 months
- C. 6-7 months
- *D. 3-5 months
- E. 1-2 months

_____32. The title of the first unit commonly used in SCIS is:

- A. Interaction
- * B. Material Objects
- C. Organisms
- D. Subsystems
- E. Temperature

_____33. The primary emphasis of Part A of the AAAS curriculum is:

- A. Classifying
- B. Measuring
- * C. Observing
- D. Using space/time relationships
- E. None of the above are correct

_____34. The process(es) dealt with in Part B of the AAAS curriculum:

- *A. Classifying, communicating, measuring, observing, using numbers, and using space/time relationships
- B. Classifying, communicating, measuring, observing, using numbers
- C. Classifying, communicating, measuring, observing
- D. Classifying and observing
- E. Communicating

_____35. As a "laboratory director" in one of the new elementary science curriculums, you can best make use of the technique of asking questions by:

- A. using them to find out if they remember what you told them yesterday
- B. using them in order to allow the children to hunt for a predetermined answer
- C. using mostly "why" questions
- *D. using mostly "how" questions

_____36. The approximate amount of preparation time needed for teaching a lesson in SCIS is:

- A 0 minutes
- B. 10 minutes
- *C. 30 minutes
- D. 45 minutes
- E. 60 minutes at least

_____37. The amount of time required for preparing a SCIS lesson as compared to that required for preparing a AAAS lesson:

- *A. SCIS required more time
- B. AAAS required more time
- C. Both AAAS and SCIS require about the same time

_____38. In considering the possibility of teacher self-instruction as a means of gaining the competency required for teaching the new science programs, which statement is most accurate?

A. Generally, both SCIS and AAAS teaching competency can be gained by teacher self-instruction
*B. Generally, neither SCIS nor AAAS teaching competency can be gained by teacher self-instruction
C. Generally, only SCIS teaching competency can be gained by teacher self-instruction
D. Generally, only AAAS teaching competency can be gained by teacher self-instruction

_____39. The amount of storage space needed to adequately accommodate the AAAS materials for a class of 30 students is:

A. five cubic feet
*B. ten cubic feet
C. twenty cubic feet
D. forty cubic feet

_____40. The minimum amount of storage space needed to adequately accommodate the SCIS materials for a classroom of 30 students is:

A. five cubic feet
*B. ten cubic feet
C. twenty cubic feet
D. forty cubic feet

_____41. What is the intensity of the problems that a third-grade transfer student might encounter upon entering either SCIS or AAAS from some other program?

A. Could easily adapt to both SCIS or AAAS
*B. Could adapt more easily to SCIS than to AAAS
C. Could adapt more easily to AAAS than to SCIS
D. Would find many adaptation problems in a similar amount in both AAAS and SCIS

_____42. The distribution of content in the AAAS program is approximately:

A. Life Sciences 50%
Physical Sciences 25%
Mathematics 10%

B. Life Sciences 25%
Physical Sciences 25%
Mathematics 10%
Other 40%

*C. Life Sciences 25%
Physical Sciences 40%
Mathematics 20%
Other 15%

D. Life Sciences 10%
Physical Sciences 75%
Other 15%

_____43. How do SCIS and AAAS lend themselves to local integration with existing curricula?

A. Content and methods can easily be adapted from both SCIS and AAAS
B. Content and methods can easily be adapted from SCIS but not from AAAS
C. Content and methods can easily be adapted from AAAS but not from SCIS
*D. Content and methods cannot be easily adapted from either SCIS or AAAS

_____44. The main purpose of using Mr. O in SCIS is:

A. to aid in identifying similarities and differences among animals outside the classroom
B. to enable the students to describe properties of an entire organism
C. to experiment with, to find the origin of detritus
*D. to act as a reference frame

_____45. In studying magnetism a child used an electromagnet to attract some paperclips. Which of the following would best describe the "system" under study?

A. Child, electromagnet, and paper clips
B. Child and electromagnet
C. Electromagnet
*D. Electromagnet and paper clips

_____46. In SCIS, the purpose for the activity in which the children compare similarly shaped pieces of aluminum, brass, pine, walnut, plexiglass, and polystyrene is:

*A. to lead to the introduction of the concept of material
B. for the identification and naming of two or more characteristics of an object (such as color and texture)
C. for the construction and demonstration of the use of a single-stage system for classifying materials
D. to gain a better understanding of the concept of inequalities

_____47. In SCIS the investigation of freon was used as a study of a(n)

A. material object
B. using space/time relationship
C. measurement
*D. subsystem
E. system

_____48. In SCIS the "systems" concept is introduced for what primary reason?

A. So that the student can better identify differences within a set of similar objects
B. So that the student can better identify body movements other than those of locomotion
C. So that the student can learn to focus his attention on parts of his environment
*D. To emphasize the principle of conservation of matter as a conceptual tool for dealing with all natural phenomena

_____49. The measurements of the earth's magnetism and the relationship of this to map reading is encountered in:

A. SCIS only
*B. AAAS only
C. Both SCIS and AAAS
D. Neither SCIS nor AAAS

_____50. The ordering of clam shells by property, using comparison signs, is encountered in:

* A. SCIS only
B. AAAS only
C. Both SCIS and AAAS
D. Neither SCIS nor AAAS

_____51. The best operational definition of the term "mass" is:

A. quantity of matter
B. the size of an object whether it is in space or on earth
*C. that property of an object which determines the amount of acceleration that will be imparted to it by a force of a given magnitude
D. that quantity of matter that when acted upon by a force will not change its velocity

_____52. The use of "models" is found in:

A. AAAS only
B. SCIS only
*C. Both SCIS and AAAS
D. Neither one

_____53. The relative amount of reading the fourth grade student is required to do in SCIS, AAAS, and ESS would be:

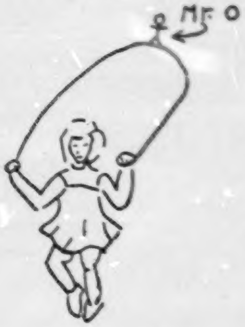
*A. more reading in ESS than in SCIS or AAAS
B. more reading in SCIS and AAAS than in ESS
C. about the same amount of reading in all three programs

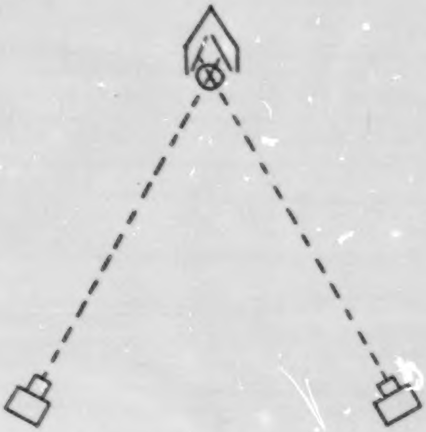
_____54. The case of the "suffocating candle" was used in AAAS to illustrate what process?

A. Observing
B. Classifying
C. Measuring
D. Communicating
E. Inferring
*F. Predicting
G. None of the above

_____55. Where are we most likely to encounter such a drawing?

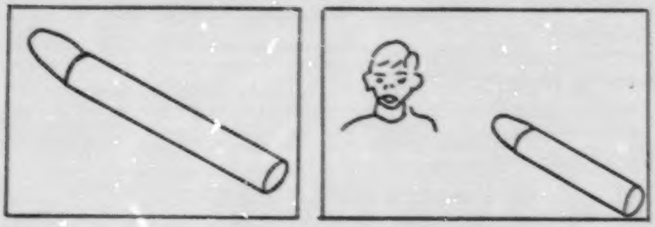
A. AAAS - Observation
B. AAAS - Using space/time relationships
C. SCIS - Subsystems
*D. SCIS - Relativity





_____56. The objective most closely associated with this laboratory setup in one of the new elementary science programs is:

- A. State that if an object does not move, the forces acting upon it must be in balance
- *B. Identify the two-dimensional projections of a given three-dimensional object
- C. Describe the positions of objects or systems
- D. Isolate and manipulate groups of objects



_____57. The series of pictures above were used in SCIS to illustrate

- A. Material Objects
- B. Inventions
- C. Measurement
- D. Relativity
- *E. Interaction

BIOLOGY STUDENT BEHAVIOR INVENTORY

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Reference: Lee, Addison E. and Steiner, H. Edwin, Jr. "The Research Potential of Inquiry Objectives in the Teaching of Biology." The American Biology Teacher, Vol. 32, No. 9:544-547, December, 1970.

BIOLOGY STUDENT BEHAVIOR INVENTORY

(Form C)

The purpose of this inventory is to obtain information about the performance and thinking of students in high school biology classes. It is not a test of knowledge about biology and will not be used to grade you or any other student. As you respond to each item, keep in mind that your response is correct only if it correctly indicates the true behavior of you or your classmates. Thus, for each item, the best response will be your accurate description of what you or others do in your biology classroom or laboratory.

A separate Answer Sheet is provided for responding to the items. Please do not write responses or make any marks on this form. Be sure to blacken the space on the Answer Sheet completely.

Respond to each item in order and do not skip any items with the intention of going back to them later. It has been found that if you consider each item carefully as you proceed, your first response will most likely be the most accurate description. Also, in a few instances, classroom situations are described in a sequential order. Skipping some of these items and going back would result in a "second-best" description of the classroom behavior.

PART I

In Part I, you will be presented with situations which have occured in biology classes and which may take place in your class. Try to picture yourself in each situation and indicate what you would do or think in each case. There are three sections (A, B and C) in Part I. Directions will be given at the beginning of each.

Section A

Directions: Each item below consists of a question or a description of a biology classroom situation and a list of things that biology students have done in such situations. From this list, select the one that you would be most likely to do in the same situation and mark the corresponding blank on the Answer Sheet.

This inventory has been developed by H. Edwin Steiner, Jr. and Addison E. Lee for investigative purposes only. No right to reproduction is granted or implied without written permission of the authors.

Example 87: If you were assigned to write a short report for your biology class, which of the topics listed below would you select?

(a) The Microscope

(b) New Discoveries in Genetics

(c) Muscle Contraction

(d) Photosynthesis

If you would prefer to write the report on the topic of Muscle Contraction, blacken the space under "c" on the Answer Sheet as shown.

Sample of Answer Sheet

	a	b	c	d
87.	[ ]	[ ]	■	[ ]

1. Assume that you are given a biology assignment to find out if an animal's rate of respiration changes immediately after he eats. Your teacher tells you that you may use any of the methods listed below to find the answer. Which one would you choose?

I would:

(a) plan and carry out my own experiment.

(b) look for the information in a reference book.

(c) propose a possible answer based on earlier studies of plant respiration.

(d) do an experiment given in the laboratory manual.

2. Assume that your biology class is doing an experiment to determine if nuclear radiation has any effect on digestive enzymes. One way to determine this is to compare the time required by an irradiated sample (experimental) with that of a non-irradiated sample (control) to digest a given quantity of a nutrient. You decide to do this with the enzyme in saliva that digests starch. The following results are obtained:

Starch is digested by the irradiated enzyme in 57 seconds.

Starch is digested by the non-irradiated enzyme in 19 seconds.

These results suggest that irradiation of this enzyme reduces its ability to digest starch.

After you collect and record the data, which one of the following would interest you most?

I would want most to:

(a) answer the question posed at the first of the experiment and complete the assignment.

(b) check my laboratory report of the experiment to see if all the required parts are included.

(c) know why or in what way irradiation affected the enzyme

(d) find out if any other student finished the experiment before I did.

3. Which of the choices below most closely describes the amount of time that you spend doing outside (non-required) reading about topics that come up in biology class?

(a) I do no reading for biology class which is not assigned.

(b) I do unassigned reading for biology class about 15 minutes per week on the average.

(c) I do unassigned reading about 30 minutes per week on the average.

(d) I do unassigned reading one or more hours per week on the average.

4. Assume that people in your neighborhood have recently been reporting that certain new types of animals and plants are beginning to appear in an open, public field, just a few miles from your school. Your biology class decides to investigate the situation as a class project. The class identifies four ways of obtaining information. These are listed below. Each member of the class is to select one method. Which Which one would you select?

I would:

(a) call the local conservation agency.

(b) talk to someone I know who has been there.

(c) read about it in the local newspaper or listen to local news broadcasts.

(d) go to the area and attempt to find out what is taking place.

5. Assume that your class has just completed an experiment in which you are determining the growth rate of a certain kind of plant. When the members of the class are discussing their results, two persons report that the growth rates of their plants are 5 cm (centimeters) per day. Your data indicate a growth rate of 8 cm per day. In such a situation, which one of the following would you do?

   I would:

   (a) change my data to 5 cm per day and report this to the class.

   (b) report to the class that according to my data, the growth rate is 8 cm per day.

   (c) remain quiet--not let anyone know what my data are.

   (d) determine the average of 5 cm and 8 cm and record this as the growth rate.

6. Based on the information given in item 5 above, I would:

   (a) conclude that the growth rate of this species of plant is 5 cm per day.

   (b) conclude that the growth rate of this species of plant is 8 cm per day.

   (c) conclude that the growth rate of this species of plant is 6 cm per day--the average of 5 cm + 5 cm + 8 cm.

   (d) want to see the results of all members of the class before deciding what the growth rate is.

7. As your class continues to discuss the experiment described in item 5 above, students report the growth rates of their plants as follows:

   4 students report 5 cm per day
   5 students report 6 cm per day
   3 students report 7 cm per day
   9 students report 8 cm per day
   2 students report 9 cm per day
   6 students report 10 cm per day

   At this point in the discussion, which of the following would you do or want to do?

I would:

(a) assume that those whose results were not 8 cm per day did the experiment incorrectly.

(b) like for members of the class to discuss the materials they used to grow the plants.

(c) conclude that a range of 5 cm to 10 cm per day represents the normal growth rate for a plant of this species.

8. Which of the choices below indicates how often you voluntarily visit science exhibits and scientific laboratories in your spare time (not as part of class project or assignment)?

(a) I never visit science exhibits or laboratories in my spare time.

(b) I voluntarily visit science exhibits or laboratories about once or twice a year on the average.

(c) I voluntarily visit science exhibits or laboratories about three or four times a year on the average.

(d) I voluntarily visit science exhibits or laboratories about four or more times a year.

Section B

Directions: The next series of items are similar to those in Section A or Part I except that you are to respond with either a YES or a NO. Read each item carefully and blacken the first space under "A" on the Answer Sheet if your response is YES. If your response is NO, blacken the second space under "B" on the Answer Sheet. Do not use the spaces under C, D and E on the Answer Sheet for items in this Section.

Example: If I needed to measure the total distance that a lizard traveled in five seconds, I would use a meter stick.

If you would use a meter stick as indicated in the statement, your response would be YES and you would blacken the first space under "A" on the Answer Sheet as shown.

Sample of Answer Sheet

	(YES)	(NO)			
	A	B	C	D	E
EX.	■	[ ]	[ ]	[ ]	[ ]

9-11 Your biology class has just finished an experiment in which you were trying to determine the minimum amount of time required by female fruit flies to mature and to become capable of reproducing after they hatch. You find the minimum time to be 13 days. After most students in the class report the same results--a time of 13 days--one student then reports a time of 10 days. How would you react to this? Indicate which of the following you would or would not do by marking either the YES or the NO space on the Answer Sheet.

I would:

9. assume that the student reporting the 10-day time made an error and disregard his results.

10. want to know if he did the experiment the same way as the others in the class.

11. conclude that when the results of most members of the class are 13 days, any other findings cannot be correct.

12. Within the last week I have voluntarily looked up information not required to complete an assignment, about something in biology.

13. While doing experiments in the laboratory, questions come to mind that I would like to have answered.

14. I did a science experiment this year that was not a class requirement.

Section C

Directions: The items below consist of opinions held by different biology students. You are to indicate the extent to which you agree or disagree with each opinion by blackening the appropriate space on the Answer Sheet as follows:

Blacken space A on the Answer Sheet if you
Strongly Agree with the opinion.

Blacken space B on the Answer Sheet if you
Agree with the opinion.

Blacken space C on the Answer Sheet if you
Don't Know whether you agree or disagree with the opinion.

Blacken space D on the Answer Sheet if you
Disagree with the opinion.

Blacken space E on the Answer Sheet if you
Strongly Disagree with the opinion.

Example: Science courses should not be offered in high schools (grades 9-12).

If you were to strongly disagree with this statement, you would blacken the space on the Answer Sheet under "E" as shown below.

Sample of Answer Sheet

	(Strongly Agree)	(Agree)	(Don't Know)	(Disagree)	(Strongly Disagree)
	A	B	C	D	E
Ex.	[ ]	[ ]	[ ]	[ ]	■

15. Even though science has progressed rapidly, there is still much that is unknown.

16. Learning biology by investigating problems as a scientist will be beneficial to me in the future.

17. Planning a laboratory experiment is fun.

18. Rapid advances in science have led to the discovery of practically everything there is to know.

PART II

On this part of the inventory, you are to describe another student in your biology class. The name of the student whom you are to describe will be provided by your teacher. As in Part I, there are no correct answers as such and you are not grading the individual. The object is for you to see how accurately you can describe what this other student does. Write your answers on the Answer Sheet and do not make any marks on this form.

Section A

Directions: From the list of choices in each of the items below, select the one which indicates what the other person would most likely do or think in each situation. When you have decided, mark the appropriate space on the Answer Sheet.

22. He (she) enjoys laboratory experiments in which he (she) must find answers for himself (herself):

    (a) very much.

    (b) some.

    (c) very little.

    (d) I do not know this person well enough to answer.

    (e) This does not apply to our biology class.

23. Assume that your biology class is trying to decide on a way to determine if the activity of a certain kind of insect is influenced by humidity. It is already known that in one corner of the classroom, the humidity is much lower than in any other part of the room. Some students in the class suggest that one way to set up the experiment would be to place several insects in each of two containers. Them place one container in the low-humidity area and the other container in a high-humidity area and observe the activity of the insects. At this point in the discussion, the student whom you are describing realizes that varying amounts of heat or light in different parts of the room may also affect the results. In such a situation, he (she) would be most likely to say:

    (a) "I do not like the procedure or method."

    (b) "Let's try this method anyway and see what happens."

    (c) "With some changes, this procedure should work well."

    (d) "This procedure needs to be changed to control other factors that may influence the insects' activity."

24. Students in your biology class are preparing materials and setting up equipment for a laboratory experiment to be carried out separately by each student. Your teacher has told the class that each member is to conduct the experiment any way he chooses that is appropriate. The person you are describing decides on a procedure for doing the experiment. Before he (she) begins, another student offers to explain a different way to do the experiment which that student thinks is better. In such a situation, which one of the reactions listed below would be most typical of the person whom you are describing?

He (she) would:

(a) tell the other student that he (she) has already decided on a procedure and does not need any other suggestions.

(b) decide to listen to the other student's ideas, but go on as planned without considering the suggestions further.

(c) decide to listen to the ideas and consider the suggestions to determine if he (she) could improve his (her) procedure.

(d) decide to use the different procedure since the other student says it is better.

25. When working in the laboratory, he (she) dislikes for anyone to bother him (her) with ideas about different ways to do something:

(a) very much.

(b) some.

(c) not at all.

(d) I do not know the person well enough to answer.

(e) This does not apply to our biology class.

26. He (she) feels that experiments in which he (she) has to find answers to many of his (her) own questions are:

(a) very interesting.

(b) somewhat interesting.

(c) not interesting.

(d) I do not know this person well enough to answer.

(e) This does not apply to our biology class.

Section B

Directions: Listed below are some things that biology students do in the classroom or laboratory. For each item, report how often the person whom you are describing does what is indicated. Blacken the appropriate space on the Answer Sheet as follows:

Blacken space A if he (she) Often does what is indicated.

Blacken space B if he (she) Sometimes does what is indicated.

Blacken space C if he (she) Seldom does what is indicated.

Blacken space D if you Don't Know how often he (she) does what is indicated

Blacken space E if the activity Does Not Apply to your biology class.

Example: He (she) is late to class.

If the person is Seldom late to class, you would mark the Answer Sheet as shown.

Sample of Answer Sheet

	(Often) A	(Sometimes) B	(Seldom) C	(Don't Know) D	(Does Not Apply) E
Ex.	[ ]	[ ]	■	[ ]	[ ]

27. He (she) asks the "why" and "how" types of questions in our biology class discussions.

28. He (she) reports his (her) laboratory data to the class even when it does not agree with the findings of others.

29. He (she) remains silent during class discussions.

30. When he (she) does something wrong in the laboratory, he (she) refuses to admit that he (she) made a mistake.

31. He (she) voluntarily does experiments or science projects which are not assigned and are not required for a grade.

32. When working in the laboratory, he (she) considers suggestions and ideas offered by others.

33. In biology class, when he (she) disagrees with someone, he (she) keeps it to himself (herself).

34. He (she) states his (her) opinions in class.

35. When some idea of his (hers) turns out to be incorrect, he (she) admits his (her) error.

36. Whenever he (she) disagrees with something or someone in biology class, he (she) explains why.

37. If his (her) results do not agree with the results of another student, he (she) changes his (hers) so that the data are consistent with that of the other student.

38. In our biology class discussions, he (she) brings up new and different ideas.

39. During our class discussions, he (she) asks for explanations of biological facts and principles.

Procedure for Administering the BIOLOGY STUDENT BEHAVIOR INVENTORY

1. Distribute No. 2 pencils (if test is to be machine scored); answer sheets; and instruction sheets with students' names and ID Numbers. Do not distribute any instruction sheet that has the name circled in red of a student who is not present when the class completes the inventory.

2. Read through the instructions with the students. Be sure that each student understands that he is to describe himself on Part I and another student on Part II and that the name of the student whom he is to describe is circled in red at the bottom of his instruction sheet. No student should have the list on which his own name is circled in red.

3. Clarify for students how to mark the required information on the answer sheet if necessary. They should be particularly careful in writing the ID Numbers and blackening in the proper spaces below the numbers if standard answer sheets for machine scoring are used.

4. When students have marked the required information on the answer sheet, have each one circle his own name on his instruction sheet with a lead pencil and then return the instruction sheet to you.

5. Distribute the BSBI forms and read through the general directions -- to Part I -- with them. Answers are to be marked on the answer sheet. If test is to be machine scored, tell students that when they mark a response on the answer sheet to blacken in the space completely but not to allow the pencil mark to extend outside the space. There is no time limit. Students will require approximately 45 minutes to complete the BSBI.

Scoring Key for the

BIOLOGY STUDENT BEHAVIOR INVENTORY (Form C)

Item No.	Score for a Given Response				
	A	B	C	D	E
1	5	1	1	1	0
2	1	1	5	1	0
3	1	2	4	5	0
4	1	1	1	5	0
5	1	5	1	1	0
6	1	1	1	5	0
7	1	5	1	0	0
8	1	2	4	5	0
9	1	5	0	0	0
10	5	1	0	0	0
11	1	5	0	0	0
12	5	1	0	0	0
13	5	1	0	0	0
14	5	1	0	0	0
15	5	4	3	2	1
16	5	4	3	2	1
17	5	4	3	2	1
18	1	2	3	4	5
19	1	2	3	4	5
20	5	4	3	2	1
21	5	4	3	2	1
22	5	3	1	0	0

Item No.	Score for a Given Response				
	A	B	C	D	E
23	1	1	1	5	0
24	1	1	5	1	0
25	1	3	5	0	0
26	5	3	1	0	0
27	5	3	1	0	0
28	5	3	1	0	0
29	1	3	5	0	0
30	1	3	5	0	0
31	5	3	1	0	0
32	5	3	1	0	0
33	1	3	5	0	0
34	5	3	1	0	0
35	5	3	1	0	0
36	5	3	1	0	0
37	1	3	5	0	0
38	5	3	1	0	0
39	5	3	1	0	0

Biology Student Behavior Inventory

Items of Subscales

Subscale	Items
Curiosity	1, 2, 3, 4, 8, 12, 13, 14, 27, 31, 39
Openness	5, 7, 9, 10, 15, 18, 24, 25, 28, 29, 30, 32, 33, 34, 35, 37, 38
Satisfaction	16, 17, 19, 20, 21, 22, 26
Responsibility	6, 11, 23, 36

Biology Student Behavior Inventory

Scoring Procedure

1. Score each item according to values shown on Scoring Key.

2. Combine item scores for each subscale. Students may respond to some items with don't know or may make an error in marking the answer sheet. Any such responses are indicated on the Scoring Key by a zero (0) and are treated as invalid data. To obtain each subscale score, compute an average or mean score counting only those items for which valid data is available (any value of 1 through 5 is a valid score) using the formula:

$$X = \frac{\Sigma i_v}{N_v}$$

where:

X = the score for the subscale.

= the sum of items with valid scores (non-zero).

N_v = the number of items with valid scores.

Example:

Obtaining Score for Subscale D

Item No.	Item Score
16	4
17	2
19	5
20	3
21	1
22	0
26	1

To calculate score for subscale D:

$\Sigma i_v = 4+2+5+3+1+1 = 16$

$N_v = 6$

$X = \frac{16}{6} = \underline{\underline{2.67}}$

INSTRUMENTS DEVELOPED BY THE EARTH SCIENCE CURRICULUM PROJECT FOR EVALUATION OF IN-SERVICE INSTITUTES

1. Student Earth Science Test
2. Student Questionnaire
3. Questionnaire for Principal, Supervisor, Curriculum Coordinator, etc.
4. Inservice Institute Questionnaire
5. Expectations Inventory

John Thompson
Research Center
Clarion State College
Clarion, Pennsylvania 16214

STUDENT EARTH SCIENCE TEST

a. Please mark all answers on answer sheet provided.
b. Do not make any marks in this test booklet.

36. The classification of rocks into three major groups is primarily based upon differences in

a. age.
b. size.
* c. origin.
d. hardness.

37. In what way does the distance between lines of longitude (meridians) change?

* a. It increases from the poles to the Equator
b. It increases from the Equator to the poles
c. It decreases from the South Pole to the North Pole
d. It remains constant at all points

Questions 38-39 are based on the following list of generalizations concerning the behavior of energy in the form of visible light.

A Light may be reflected from, transmitted through, or absorbed by materials in its path.
B Light travels in straight lines.
C Light may change its direction when it passes from one material to another.
D The speed of light is constant in a uniform material.

Choose the generalization which BEST explains each of the following situations.

38. Light from the sun reaches the earth's atmosphere in a relatively constant amount, but the light intensity varies from day to day at any given location on the surface.

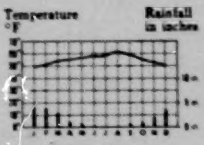
* a. A
b. B
c. C
d. D

39. The actual position of a star in the sky can be determined from an artificial satellite by sighting with a precision telescopic instrument.

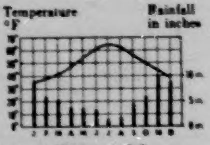
a. A
b. B
* c. C
d. D

Questions 40-43 are based on the following graphs.

The top curve on the two graphs represents average monthly temperatures for San Francisco, California, and Vancouver, British Columbia, Canada. The bars on the bottom of the graphs represent average monthly rainfall for the two cities. The letters at the bottom of the graphs stand for the months.



San Francisco, Calif.



Vancouver, B.C.

40. From the temperature data it can be determined that

a. both cities have average monthly temperature increases in winter.
* b. both cities have highest average temperatures in summer.
c. average monthly temperatures rise in winter in Vancouver, but drop in San Francisco.
d. average monthly temperatures reach a peak in summer in San Francisco, but not in Vancouver.

41. From these graphs, which of the following statements can be made about the rainfall in the two cities?

* a. Both cities get maximum rainfall in winter
b. Both cities get most of their rainfall in summer
c. Vancouver gets more rain in winter, but San Francisco gets more in summer
d. San Francisco gets most of its rainfall in winter, but Vancouver gets most of its rainfall in summer

42. Which of the following conclusions about climate may most correctly be drawn from the data given?

a. California and British Columbia have similar climates
* b. San Francisco and Vancouver have similar climates
c. California has the opposite kind of climate from that of British Columbia
d. San Francisco has the opposite kind of climate from that of Vancouver

43. On the basis of the graphs, what is the relationship between temperature and rainfall in these cities?

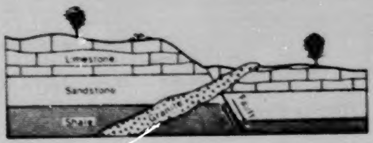
a. Rainfall increases as temperature increases
* b. Rainfall decreases as temperature increases
c. Rainfall decreases as temperature decreases
d. Rainfall and temperature are independent

Go on to next page ...

44. The planet Neptune is believed to have only two satellites. Over a period of several years an astronomer makes observations which lead him to suspect there is a third satellite near this planet, but he is not certain. What procedure is it most proper for him to follow?
   a. Keep his data to himself until he can say with certainty whether his suspicions are correct
   b. Destroy all his data and make a fresh start on the problem, using other techniques of observation
* c. Publish his observations and his conclusions, making it clear that the conclusions are strictly tentative
   d. Announce to the world that Neptune has three satellites, and leave it to others to prove him right or wrong

45. What is the major process that results in the formation of dew?
   a. Radiation
   b. Vaporization
* c. Condensation
   d. Solidification

Questions 46-48 are based on the following diagram which represents a cross-section of a portion of the earth's crust showing various rock units and a fault. The diagram indicates that there has been movement of the rock on one side of the fault relative to that on the other side.



46. Which of the rock units is the oldest?
* a. Shale
   b. Granite
   c. Sandstone
   d. Limestone

47. Which of the rock units is youngest?
   a. Shale
* b. Granite
   c. Sandstone
   d. Limestone

48. The fact that the granite is continuous through the fault indicates that the granite formed
   a. before the faulting occurred.
* b. after the faulting occurred.
   c. at the time of the faulting.
   d. at two different times.

49. An instrument used to record movements in the earth's crust is a
   a. barograph.
* b. seismograph.
   c. thermograph.
   d. spectrograph.

50. Where is most underground water found?
   a. In areas of oil fields
* b. In small pore spaces in rock
   c. In large underground lakes or pools
   d. In underground rivers or streams

51. The attraction due to gravity on a planet is determined by its
* a. mass and radius.
   b. surface features.
   c. atmospheric density.
   d. distance from the sun.

52. Which of the following is NOT one of the major groups of rocks?
   a. Igneous
* b. Metallic
   c. Metamorphic
   d. Sedimentary

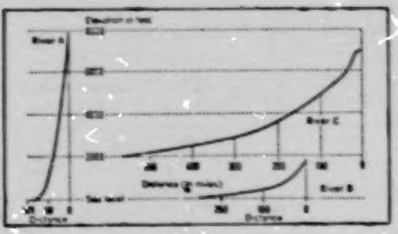
53. Isobars on a weather map connect points of equal
   a. temperature.
* b. air pressure.
   c. precipitation.
   d. wind direction.

54. Which of the following does NOT affect the length of time it takes a planet to revolve around the sun?
* a. Size of planet
   b. Length of orbit
   c. Distance from sun
   d. Gravitational pull of sun

Go on to next page ....

Questions 55-57 are based on the graphs below.

These graphs represent the exaggerated profiles of three rivers as they flow from their source to where they flow into another body of water (mouth). A river erodes the bottom of its channel most where it flows the fastest, that is where it drops the greatest vertical distance in the shortest horizontal distance.



55. Which of the following statements would most likely be true about the rate of flow of the three rivers if we assume the same volume of water is flowing in each?
- * a. River A has the fastest rate of flow
- b. River B has the fastest rate of flow
- c. River A has the slowest rate of flow
- d. River C has the slowest rate of flow

56. The rate of downward erosion along River C is LEAST between the elevations of
- * a. 2,000 and 3,000 feet.
- b. 3,000 and 4,000 feet.
- c. 4,000 and 5,000 feet.
- d. 5,000 and 7,000 feet.

57. Which of the following could be concluded from the diagrams?
- a. River B joins River C
- b. River B empties into a lake
- * c. River C does not empty into the sea
- d. River A and River C have the same source

58. Approximately how long does it take the moon to revolve around the earth?
- a. Twenty-four hours
- b. One week
- * c. Four weeks
- d. Three months

59. The condition of the atmosphere at any one time and place is known as
- a. climate.
- * b. weather.
- c. a stationary front.
- d. atmospheric circulation.

60. The region north of the Arctic Circle will have 24 hours of darkness on
- a. March 21.
- • b. June 21.
- c. September 21.
- * d. December 21.

61. The amount of water vapor contained in a given volume of air is the
- a. dew point.
- b. precipitation.
- * c. absolute humidity.
- d. atmospheric pressure.

Questions 62-64 are based on the following situation.

A scientist wants to measure the rate of decomposition of limestone when treated with acid A. He uses two identical pieces of limestone, treating them continuously with the acid for ten minutes.

62. What calculation would be used to determine the rate of disintegration per minute?
- a. 10 × weight of limestone lost
- b. $\frac{10}{\text{weight of limestone lost}}$
- * c. $\frac{\text{weight of limestone lost}}{10}$
- d. $\frac{10 \times \text{weight of limestone lost}}{\text{original weight of limestone}}$

63. What formula would be used to determine the total per cent of limestone lost after the 10 minutes?
- a. $\frac{\text{weight of limestone lost}}{\text{weight of limestone remaining}} \times 100$
- * b. $\frac{\text{weight of limestone lost}}{\text{original weight of limestone}} \times 100$
- c. $\frac{\text{weight of limestone remaining}}{\text{original weight of limestone}} \times 100$
- d. $\frac{\text{weight of limestone remaining} - \text{weight of limestone lost}}{\text{original weight of limestone}} \times 100$

64. If a significant difference were found in the rate of decomposition of the two pieces of limestone, such results would most likely be due to an error in the
- a. choice of acid.
- b. mathematical computation.
- c. scientific hypothesis.
- * d. experimental procedure.

Go on to next page .....

65. An increase in the barometric pressure is usually a forecast of

a. rain.
b. high winds.
* c. clearing skies.
d. a sudden rise in temperature.

66. Soil is different from rock because soil

a. is dark in color.
* b. supports plant life.
c. is heavier than rock.
d. does not contain minerals.

67. Stars differ from planets in that they

a. revolve around the earth.
* b. give off their own light.
c. are seen by reflected light.
d. are much smaller than planets.

68. Which of the following can NOT be classified as a fossil?

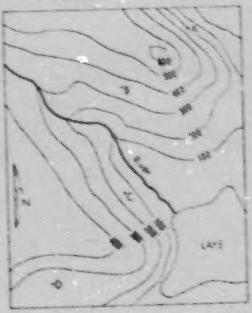
* a. A shell of a clam washed ashore on a beach
b. A grasshopper preserved in volcanic ash
c. The impression of a fern leaf in a piece of coal
d. The footprint of a dinosaur found in a solid rock

69. Green plants are not found at great depths in the ocean because

a. carbon dioxide and oxygen are not found in water at great depths.
b. the pressure of water at great depths in the ocean would crush the plants.
c. creatures living at great depths in the ocean destroy them.
* d. sunlight does not reach the depths of the ocean.

Questions 70–72 are based on the following map which represents a part of the earth's surface.

Hills and valleys are shown by means of contour lines. Each contour line indicates that all points on the line have the same elevation above sea level.



70. In what direction does the river flow?
a. Northeast
* b. Southeast
c. Northwest
d. Southwest

71. The highest point on the map is between
a. 500 and 600 feet above sea level.
* b. 600 and 700 feet above sea level.
c. 1000 and 1100 feet above sea level.
d. 2100 and 2200 feet above sea level.

72. The steepest slope is near point
* a. A.
b. B.
c. C.
d. D.

73. Which points can be seen from point B?
a. A only
* b. C only
c. A and C
d. C and D

74. An object that orbits a planet is called

a. a star.
b. a meteorite.
* c. a satellite.
d. an asteroid.

75. In the ocean, most surface waves are a result of

a. tides.
* b. wind action.
c. earthquakes.
d. the revolution of the earth.

END OF TEST

Row F-2

STUDENT QUESTIONNAIRE

Instrument 3, Form 2

NOTE: SD = Strongly Disagree A = Agree ? = No opinion or does not apply
SA = Strongly Agree D = Disagree

1. My age is (if younger than 13, leave blank) 13 b 14 c 15 d 16 e more than 16 f

2. I am a Boy b Girl c

3. The course I am taking from the teacher who gave me this questionnaire is:
   - a. Earth Science
   - b. Biological Science
   - c. General Science
   - d. Physical Science
   - e. Other

4. I am interested in earth science. SA a A b ? c D d SD e

5. My teacher allows the students to make suggestions about what we will study. SA a A b ? c D d SD e

6. I can find science topics of interest to me personally SA a A b ? c D d SD e

7. I can help the class set its own directions on what to study and how to study them. SA a A b ? c D d SD e

8. My teacher is good at pointing out ways earth science affects us. SA a A b ? c D d SD e

9. My teacher seems to be excited and enthused about earth science. SA a A b ? c D d SD e

10. I can grade myself. SA a A b ? c D d SD e

11. I cannot learn unless I am supervised. SA a A b ? c D d SD e

12. The study of earth science seems important to me. SA a A b ? c D d SD e

13. My earth science classes are very worthwhile SA a A b ? c D d SD e

14. My teacher is good at conducting our lab investigations. SA a A b ? c D d SD e

15. What I have learned in earth science will probably never be very useful SA a A b ? c D d SD e

TURN PAGE OVER AND CONTINUE

16.	I can do science without knowing much about the subject.	SA a	A b	? c	D d	SD e
17.	I can interact with the teacher as an equal	SA a	A b	? c	D d	SD e
18.	My teacher seems to know quite a lot about earth science	SA a	A b	? c	D d	SD e
19.	I can usually understand everything my teacher discusses in class.	SA a	A b	? c	D d	SD e
20.	I should not be allowed to choose my own lab partner.	SA a	A b	? c	D d	SD e
21.	I can trust the teacher.	SA a	A b	? c	D d	SD e
22.	Earth science lab work is not worthwhile	SA a	A b	? c	D d	SD e
23.	My teacher seems interested in what I have to say about earth science.	SA a	A b	? c	D d	SD e
24.	My earth science class is often boring	SA a	A b	? c	D d	SD e
25.	Careful observation is a good way to find out what is going on around me.	SA a	A b	? c	D d	SD e
26.	There is usually more than one reasonable explanation for most observations	SA a	A b	? c	D d	SD e
27.	Earth science is a class where I can express my own ideas freely	SA a	A b	? c	D d	SD e
28.	We seem to have freedom in class.	SA a	A b	? c	D d	SD e
29.	Earth science lab work is interesting	SA a	A b	? c	D d	SD e
30.	Earth science is one of my favorite subjects.	SA a	A b	? c	D d	SD e
31.	We should do more lab work in earth science	SA a	A b	? c	D d	SD e
32.	Earth science lab work is difficult	SA a	A b	? c	D d	SD e
33.	All students should take earth science for at least one year	SA a	A b	? c	D d	SD e
34.	My teacher is good at presenting material so I can understand it	SA a	A b	? c	D d	SD e

Row E-4
Row F-2

QUESTIONNAIRE FOR PRINCIPAL, SUPERVISOR, CURRICULUM COORDINATOR, ETC.

Instrument 4, Form 2

Directions: Please mark each statement on your answer sheet by filling in the appropriate space. Please do not leave any blanks. Answer all questions.

NOTE: SD = Strongly Disagree A = Agree ? = No opinion or does not apply
SA = Strongly Agree D = Disagree

1.	I believe the In-service Institute Program generally meets real needs for my teacher(s).	SA a	A b	? c	D d	SD e
2.	Field trips for students are encouraged by this teacher.	SA a	A b	? c	D d	SD e
3.	I think that this teacher's students can find science topics of personal interest if permitted to do so.	SA a	A b	? c	D d	SD e
4.	Field work makes earth science more relevant to students.	SA a	A b	? c	D d	SD e
5.	This teacher's students are capable of setting their own directions in determining their own curriculum.	SA a	A b	? c	D d	SD e
6.	The In-service Institute participant involves his students in lab work about what proportion of the time?	0 a	25 b	50 c	75 d	100% e
7.	The In-Service Institute participant expresses enthusiasm for his institute study.	SA a	A b	? c	D d	SD e
8.	This teacher's students are capable of grading themselves if given an opportunity.	SA a	A b	? c	D d	SD e
9.	This teacher's students cannot learn unless supervised by the teacher.	SA a	A b	? c	D d	SD e
10.	This teacher's students can do sicence without knowing much about the subject.	SA a	A b	? c	D d	SD e
11.	This teacher's students are capable of interacting with their teacher as an equal.	SA a	A b	? c	D d	SD e
12.	The In-service Institute participant seems to sense the needs of his students.	SA a	A b	? c	D d	SD e
13.	The students in his classes feel that he is a good teacher.	SA a	A b	? c	D d	SD e

14.	His students usually seem actively involved in earth science subject matter.	SA a
15.	The In-service Institute participant seems to know a good deal about earth science.	SA a
16.	The In-service Institute participant is generally enthusiastic about teaching earth science.	SA a
17.	Students trust the teacher participating in this Institute.	SA a
18.	This teacher needs additional earth science background.	SA a
19.	His students are generally pleased with his class management.	SA a
20.	This teacher needs some experiences in the modern philosophy of science teaching.	SA a

IN-SERVICE INSTITUTE QUESTIONNAIRE

Instrument 7, form 2

Directions: Please mark each statement on your answer sheet by filling in the appropriate space. Please do not leave any blanks. Answer all questions.

NOTE: SA = Strongly Agree A = Agree

SD = Strongly Disagree D = Disagree ? = No opinion or does not apply

1. Your students now spend about what proportion of time in laboratory work	0 a	25 b	50 c	75 d	100% e
2. Your students now have what percentage of time to express their own ideas	0 a	25 b	50 c	75 d	100% e
3. You present material to your students without questions or discussion about what proportion of time	0 a	25 b	50 c	75 d	100% e
4. Percent of time spent working with ideas generated by students rather than by the text or teacher	0 a	25 b	50 c	75 d	100% e
5. How much class time is devoted to topics and/or activities determined by a free choice of students	0 a	25 b	50 c	75 d	100% e
6. Your students' greatest needs than can be met through your school's science program are to become more proficient inquirers	SA a	A b	? c	D d	SD e
7. Your students' greatest needs that can be met through your school's science program are to improve ability to predict	SA a	A b	? c	D d	SD e
8. Your students' greatest needs that can be met through your school's science program are to learn conservation practices	SA a	A b	? c	D d	SD e
9. Your students' greatest needs that can be met through your school's science program are to provide awareness of use of math in science	SA a	A b	? c	D d	SD e

10.	Your students' greatest needs that can be met through your school's science program are to improve problem solving ability	SA a	A b	? c	D d	SD e
11.	Your students' greatest needs that can be met through your school's science program are to illustrate interactions of man and nature	SA a	A b	? c	D d	SD e
12.	Your students' greatest needs that can be met through your school's science program are to develop good technique in laboratory	SA a	A b	? c	D d	SD e
13.	Your students' greatest needs that can be met through your school's science program are to acquire reasonable knowledge in science	SA a	A b	? c	D d	SD e
14.	Your students' greatest needs that can be met through your school's science program are to develop a system of concepts on which he can build his knowledge	SA a	A b	? c	D d	SD e
15.	One of the greatest handicaps to your students being able to learn well in your science classes is Students are not interested	SA a	A b	? c	D d	SD e
16.	One of the greatest handicaps to your students being able to learn well in your science classes is You have a weak background in earth science	SA a	A b	? c	D d	SD e
17.	One of the greatest handicaps to your students being able to learn well in your science classes is: Students cannot communicate their ideas	SA a	A b	? c	D d	SD e
18.	One of the greatest handicaps to students being able to learn well in your science classes is: You cannot communicate well with your students	SA a	A b	? c	D d	SD e
19.	What % of your students can observe natural phenomena well.	0 a	25 b	50 c	75 d	100% e
20.	What % of your students seem to value their study of science	0 a	25 b	50 c	75 d	100% e

21.	What % of your students' curiosity about science seems to be high	0 a	25 b	50 c	75 d	100% e
22.	What % of your students' enthusiasm about science seems to be high	0 a	25 b	50 c	75 d	100% e
23.	What % of your students' involvement with science is high	0 a	25 b	50 c	75 d	100% e
24.	You allow your students to be active in the class room	SA a	A b	? c	D d	SD e
25.	You ask questions of your students frequently	SA a	A b	? c	D d	SD e
26.	You give laboratory performance tests	SA a	A b	? c	D d	SD e
27.	You let students talk freely	SA a	A b	? c	D d	SD e
28.	You use laboratory experiences frequently	SA a	A b	? c	D d	SD e
29.	You think your students are interested in what you have to say	SA a	A b	? c	D d	SD e
30.	You have accurate up to date earth science information for your students	SA a	A b	? c	D d	SD e
31.	You expect from the institute: Better understanding of students as human beings	SA a	A b	? c	D d	SD e
32.	You expect from the institute: Better understanding of yourself as a person	SA a	A b	? c	D d	SD e
33.	You expect from the institute: Improved earth science background	SA a	A b	? c	D d	SD e
34.	You expect from the institute: Better understanding of new earth science curriculum materials	SA a	A b	? c	D d	SD e
35.	You expect from the institute: Better understanding of interrelationships in the sciences	SA a	A b	? c	D d	SD e
36.	You expect from the institute: Up-to-date factual knowledge in the earth sciences	SA a	A b	? c	D d	SD e

		SA	A	?	D	SD
37.	You expect from the institute: Improved teaching techniques	a	b	c	d	e
38.	You feel qualified to discuss earth science topics with your students	a	b	c	d	e
39.	You feel adequately prepared to teach physical geography	a	b	c	d	e
40.	You feel adequately prepared to teach astronomy	a	b	c	d	e
41.	You feel adequately prepared to teach geology	a	b	c	d	e
42.	You feel adequately prepared to teach oceanography	a	b	c	d	e
43.	You feel adequately prepared to teach meteorology	a	b	c	d	e
44.	You feel adequately prepared to evaluate student learning	a	b	c	d	e
45.	You feel adequately prepared to teach a laboratory program	a	b	c	d	e
46.	You feel adequately prepared to handle student-teacher interaction	a	b	c	d	e
47.	You feel adequately prepared to take students on field trips	a	b	c	d	e
48.	You feel adequately prepared to teach interdisciplinary science	a	b	c	d	e
49.	You feel you understand yourself pretty well as a person	a	b	c	d	e
50.	You feel you understand students as human beings	a	b	c	d	e

EXPECTATIONS INVENTORY (Instrument 2, Form 2)

Directions: Please mark each statement on the answer sheet by filling in the space under a, b, c, d, or e. Consider "your students" as the student population who are in your classes. If you have never taught make an honest judgement of what you think students could do.

a. Few of my students could do this if given the opportunity

b. 1/4 of my students could do this if given the opportunity

c. 1/2 of my students could do this if given the opportunity

d. 3/4 of my students could do this if given the opportunity

e. All of my students could do this if given the opportunity

1. Make scientific observations
2. Recognize value in working with other people
3. Experience the intrinsic rewards of learning
4. Select extrinsic stimulation to motivate themselves
5. Have fun selecting their own topic for study
6. Find earth science topics of interest to them personally
7. Help the class set its own directions
8. Establish their own curriculum
9. Grade themselves
10. Learn without supervision
11. Demonstrate what they learned
12. Learn by only competing with themselves
13. Appreciate the personal value in doing science
14. Learn science without strong science background
15. Do earth science without knowing much about the subject
16. Enjoy science
17. Interact with the teacher as an equal
18. Choose lab partners on their own

19. If left unsupervised, work on science

20. Voluntarily do earth science outside of school hours

21. Read science books without assignments

22. Show concern for environmental problems and man

23. Trust the teacher

24. Teach other students